PERIODICAL ROOM
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SCIENTIFIC AMERICAN

DETECTING THE APPROACH OF AN ENEMY AIRCRAFT WITH A FRENCH "POSTE D'ECOUTE."—[See page 377.]

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October 30, 1915

Munn & Co., Inc., Publishers
New York, N. Y.

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S. A.

We Americans hear about the Allies chiefly from the British standpoint. Somehow we almost overlook the other powers that make up the Entente. In "The Truth About France", Owen Johnson tells what our sister republic has done and is doing in the war. His story of the spirit behind France and its hopes for after-the-war will appear in the October 30th issue of

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Panama Canal choked by slides. Gaillard cut looking toward Miraflores Lake

How the Slides Develop At Panama

FROM among the many illuminating photographs which have been taken of the recent slides at Panama, we have selected one, which shows how the bottom has been upheaved above the surface of the water, to a height of over 45 feet above the bottom of the canal. Broadly speaking, the moving mass comes down into the cut, either by sliding or by crushing. Where the material has been sloped at a deeper angle than that at which it can naturally stand, it keeps slipping off until the natural angle of repose has been reached. Another form of sliding occurs when the overlying material is resting upon rock or some harder material than itself, which slopes toward the canal. As the excavation is carried down, the overlying mass becomes so heavy as to overcome the frictional resistance between itself and the harder material beneath, and it commences to move into the excavation. The movement is frequently assisted by surface drainage water, which, trickling along the natural line of separation, lubricates the surface and assists the movement.

Another form of slide is that which is due to crushing or disintegration of the material. This occurs when the underlying rock is of poor quality, or is intersected by vertical seams or seams which slope toward the canal. As the depth of the excavation increases, the weight of the superincumbrance mass along the face of the cut becomes so great that the material at the foot of the excavation is crushed; it loses its cohesion, breaks up, and is pushed down and outward toward the center of the excavation. Being resisted by the reactive effect of the undisturbed floor and the opposite foot of the cut, the material is forced, sometimes, as high as 20 to 30 feet above the original bottom of the cut. Apparently in the case of the present slide, it has been forced up over 45 feet. The "hump," as it is called, "A" (see accompanying sketch) rises until a point is reached where an equilibrium is established between the weight of the hump and the weight of the sliding section "B" on the side of the cut, less the frictional resistance to movement along the line of cleavage.

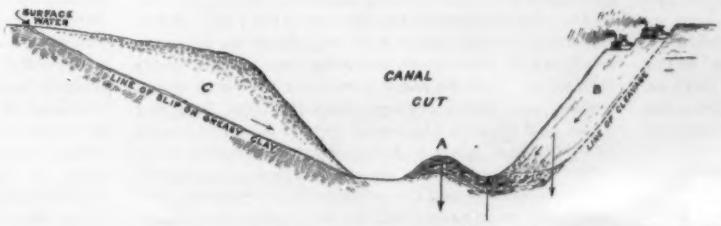

Diagram showing the action of slides in the Culebra cut

Shall We Take a Cold Bath to Cool Off After Exercising?

FROM experiments conducted at the Harvard Physiological Laboratory one gains very useful information on what *not* to do in the summertime after exercising. Primarily this work was undertaken to determine if the increased pulse rate resulting from exercise is related to the increase in body temperature. Aside from the purely scientific results which showed that the two are independent of each other, it was found that the baseball player, tennis player, or even the pedestrian, is not cooler after the cold bath, which is expected to lower his temperature, but that his body is actually warmed by the process.

We have all experienced the delightful sensation of a cold bath after undue activity in warm weather. Likewise we have all felt the heightened temperature afterward. This we usually attribute to the psychological effect produced by the difference in temperature between the cold water in which we bathe and the warm air into which we afterward emerge. We always feel warmer after a cold bath. Experiments show that we actually are warmer.

The person on whom the data were collected at Harvard exercised by running up and down stairs for a stated period of time, then reclined upon a couch for 6 minutes. Then he arose and a stream of cold water was thrown over his body for 5 minutes. At the end of that time he returned to the couch for 3 minutes; then he again enjoyed a cold bath. After that he was permitted to rest upon the couch for 50 minutes. At all stages, from beginning to end of the experiment, records were taken on the pulse rate and temperature. These showed that, starting with a pulse rate of 63 per minute, there was an increase to 146 per minute after the exercising had ceased. From this point there was a continual decrease to normal, the rate being 82 per minute just before the second bath and 72 2 minutes after the bath. The temperature, however, behaved differently. Just before the running commenced it was 98.29 deg. Fahr., before the first bath 99.41 deg. Fahr., and after this 99.1 deg. Fahr. Then it arose during the next 3 minutes to 99.71 deg. Fahr. This increased temperature was maintained in spite of the second bath, and the maximum, slightly exceeding this, reached 22 minutes after the cessation of exercise. From that time there was a gradual decrease, the minimum of 98.1 deg. Fahr. being reached about 20 minutes later.

By means of an electric fan, the temperature fell from the time the exercise ended, returning to the original temperature in 22 minutes. When neither a current of air nor cold water was applied the temperature began to fall in about 6 minutes after the exercising had ceased.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Rehabilitating the United States Navy

TWELVE months ago, the attitude of the present Administration on the question of increasing our naval and military defenses was one of uncompromising opposition. Specific orders were given, sealing the lips of our naval and military men and strictly prohibiting them from giving any information or making any statement whatsoever upon the subject of military preparedness. Moreover, the growing concern of the nation regarding our state of unpreparedness, as expressed in the activities of the Navy League, the National Security League, the American League and other patriotic associations, was denounced in semi-official utterances as being an attempt to provoke a "militaristic" spirit which was inconsistent with the traditions and present policy of the United States.

To-day, we witness one of the most extraordinary changes of front that have occurred in the history of official Washington; for the daily press is being filled with evidently inspired articles, sent out broadcast from the War and Navy Departments, in which it is announced that the forthcoming Congress is to be asked to make considerable additions to our naval and military forces.

This change of attitude on the part of the administration we sincerely welcome and we believe the Government has modified its policy because of the conviction that circumstances demand it. We are satisfied that it is determined to push the proposed measures through Congress with all the pressure that it can bring to bear.

So far as the plans which have been given such lavish publicity are concerned, we are thoroughly in accord with the proposal to lay down a continuing program of construction extending over the next six years. This is the principle upon which the German navy has been built up; it is in keeping with the plan outlined many years ago by the General Board of the Navy; and the institution of such a program cannot fail to have a stimulating effect upon successive congresses when the question of naval increase comes up. It should be remembered, however, that imposing as are the totals representing the whole six years' program, *it is with the appropriation for the present year, and that alone, that the nation is immediately concerned.* Future congresses will be in no wise obligated to follow the yearly program, as thus laid down, and therefore it would be well for the nation to keep its eyes fixed upon the appropriations which are asked for the present year. With regard to these, we feel it our duty to state that they are insufficient. Not only so, but the whole program, both for the current year, and for the five following years, fails to meet the exigencies of the situation, as recognized and provided for by the continuing program advocated several years ago by the Naval Board.

The plans of the board were drawn with a strict regard to the continuing program of a certain European power, whose international policies seemed most likely to bring it into conflict with the United States. The Naval Board program called for such yearly addition to our strength as would give us by the year 1920 a total of forty-eight battleships, or one for every state in the Union.

Unfortunately Congress for the past decade has seen fit to cut down the recommendations of its naval experts to such an extent that to-day we are far below the standard of strength necessary for our protection. If the present Administration is sincerely desirous of executing the freely-expressed will of the country, it should lay out a program of construction, which shall not merely make such yearly additions to our navy as are contained in the original program of the Naval Board, but it should increase them by an amount equal to the omissions of the past ten years. In other words, the new program should be so ordered that by the year 1920 we shall possess a total of forty-eight battleships.

As matters stand to-day, we have seventeen dreadnoughts built, building and authorized. The program of the present Administration calls for the construction of sixteen dreadnoughts within the next six years, which would give us thirty-three by 1920. As regards pre-dreadnoughts, if we strictly apply the rule that such ships are obsolete after twenty years of service, we find that by 1920 we shall have only eight such ships available, namely, the vessels of the "Michigan," "New Hampshire" and "Connecticut" classes. Adding these eight to the thirty-three dreadnoughts, we get a total of forty-one battleships by 1920.

Now for reasons stated above, *the immediate concern of the country is with the program for the present year;* for it would be perilous to allow the summed-up totals of proposed future construction (ships which may never be built) to divert our attention from the urgent needs of the hour. The addition to our first fighting line for the present year should be as large as our shipbuilding accommodations, governmental and private, will admit of. The program set forth, unofficially, by the Navy Department, calls for two dreadnoughts and two battle cruisers. It should be enlarged by the addition of two more battle cruisers, making six dreadnoughts in all. By the enlargement of certain shipbuilding ways, it would be possible to lay down six capital ships this year or in the spring of next year. This should be followed by four dreadnoughts in 1916 and in 1917, and by three dreadnoughts in the years 1918, 1919 and 1920. This would give us an addition of twenty-three dreadnoughts by 1920, which, added to the seventeen already built or under construction, or authorized, would give us forty dreadnoughts by that year. Adding the eight pre-dreadnoughts which would still be within the age limit, and we would have by 1920 the full quota of forty-eight battleships, regarded by the Naval Board as the minimum required for the safety of the country.

So far as the matériel of the Navy is concerned, its most pressing need to-day is a division of battle cruisers. The foreign nations build their ships in groups or divisions of four; Japan has her four Kongos; Great Britain built her four Inflexibles and then her four Princess Royals. Germany has her four battle cruisers of the Seidlitz type. To obtain their full efficiency we should lay down simultaneously at least a division of four such ships. This, with the two dreadnoughts asked for, would give us a total of six dreadnoughts for this year's program—none too many, in view of the fact that, because of the munitions question, the second greatest naval power in the world has to-day, and will have for many a year to come, a deep-seated grievance against this country.

In regard to the design of these battle cruisers, we believe that the 35-knot ships that have been spoken of in the recent despatches from Washington would be a decided mistake. No such speed is necessary. The objection of the Navy Department to the construction of battle cruisers has been on the ground that, because of their light armor, they were unable to lie in the battle line. This objection could be overcome by a compromise; and we suggest that four 29-knot battle cruisers carrying each eight 16-inch guns, and protected by 12 inches of armor, could be built within the limit of the displacement of the "Pennsylvania," or, say, thirty-two to thirty-three thousand tons. There is already afloat a prototype of such a ship in the British "Queen Elizabeth," which on 27,500 tons combines a battery of eight 15-inch guns, a speed, on trial, of 26½ knots and an armor belt of 12 inches thickness. An increase of 4,000 tons in the displacement of the "Queen Elizabeth" would surely make it possible to raise the speed two or three knots, and substitute 16-inch for 15-inch guns. If these ships were built the Navy would possess four battle cruisers more powerful than any afloat, and capable, because of their 12 inches of armor, of taking their place in a line-of-battle engagement.

The Navy Department program calls for twenty-five coast submarines and five ocean-going submarines. The experience obtained during the war maneuvers of last spring and this fall has proved that our coast submarines are serviceable only within a limited distance from their base—they are utterly unsuited for cruising with the main fleet. It is the opinion of our naval officers that if we are to build submarines, they should be of the sea-going type and of not less than twelve to fifteen hundred tons displacement. We suggest, therefore, that a better program would be to build a dozen ocean-going submarines and omit altogether the proposed coast submarines, leaving coast defense to our existing flotilla of seventy-five non-sea-going submarines.

The addition of twelve destroyers is desirable, and they should be of the largest sea-going type. The proposed addition of three scouts is altogether too limited. We need at least a dozen of these. The suggested increase of 8,000 enlisted men does not meet the emergency. As matters stand to-day, the Navy is short at least 18,000 enlisted men.

Lastly, the proposed appointment of 250 more midshipmen to the Naval Academy is merely toying with the difficulty. Our Navy is already short 1,000 officers, and the additional ships which the Navy should lay down in the present year will call for at least 500 officers to man them. We are now, and we have been for some time, building ships much faster than we have been preparing officers to handle them. Provision should be made for at least 1,000 additional midshipmen to meet the present very critical conditions.

Explosion Risk of Dynamite Cargoes

RESIDENTS at Gravesend Bay and Sea Gate, and the owners of passenger vessels whose course took them near to the German dynamite ship which, since the opening of the war, has been moored off Bath Beach, will be gratified to learn that the consignees have ordered that the ship's cargo be unloaded and returned to the manufacturers. That the risk of explosion was more theoretical than real, is suggested by the fact that the ship laid at its present anchorage during the hot months of two summers without any mishap. The risk of detonation of such a cargo as this lies in the fact that the absorbent material which holds the nitro-glycerin is apt to permit the liquid to escape when exposed to heat. Instances have occurred where the nitro-glycerin, resulting from the deterioration of the powder, had soaked through the wooden boxes containing the dynamite. Nitro-glycerin can be readily detonated by being subjected to even a slight rubbing between two metal surfaces. If the boxes have exposed nail heads and there has been a leakage along the nails, there is an evident danger of the whole cargo being detonated through friction. An efficient safeguard against this, is the practice of some European explosive manufacturers of packing the dynamite in rubber-lined boxes, a provision which effectually prevents any escape of nitro-glycerin. Furthermore, in the case of large cargoes, such as the one in question, the boxes are so packed as to permit free ventilation, and most careful attention is paid to the temperature in the holds. Self-preservation is the first law of life; and it may be taken for granted that the captain and crew who sleep above a cargo of dynamite use every precaution, in the way of the frequent opening of hatches, artificial ventilation and constant inspection, to safeguard the ship against disaster.

A German on Permanent Fortifications

ALTHOUGH the war is still in progress, German military men are beginning to write illuminating articles, in which are embodied the vital lessons of the war. Of such a character is a paper by "Frobenius" on "The Fortress in Present War," published in *Kriegstechnische Zeitscrift* and republished in the *International Military Digest Quarterly.* From this writer we learn that at Namur the Germans brought up thirty-two modern siege pieces, which were placed in two groups, at about three miles from the Belgian line. These, we are told, hammered away at a single section of the defenses and were themselves well out of the way of the heaviest Belgian ordnance. The garrison clung to the trenches for protection without being able to answer the fire. It is an actual fact, we are told, that Fort Maizeret fired only ten rounds; whereas, it was itself struck by 1,200 shells, fired at the rate of twenty a minute. Little wonder is it that the fort succumbed. According to this authority, the two all-important phases in the defense of a fortified place will be: First, the checking of the enemy's advance at a point well outside of effective range of his artillery, and, second, minimizing the target offered by the permanent works. The first condition can be brought about by an unusually spirited action on the part of the garrison, well in advance of the main line, this being supplemented by the fire from the fort's long-range guns. It is admitted that, when it comes to size and weight of guns, the fortress has the advantage, since it can be fitted out with ordnance, the like of which no army can ever hope to bring into the field.

It is considered that the reinforcement of old work with concrete and armor is a hopeless task, the solution lying in another direction. "Frobenius" would cut down the size of the structures, utilize natural features of the terrain, and distribute the elements of defense over a larger area. Concealment must be sought at any price. Hitherto the only fort that has held out has done so by acting in conjunction with a strong mobile force. Brailmont, we are told, stands to-day discredited. His idea of concentration of strength in single works has proved to be a failure. In the future the post must be fought in close cooperation with its reserves, consisting of a mobile body of troops placed outside of and well beyond the line.

On the other hand, "C," writing in the same journal, believes that the modern fortress will form a staunch bulwark of defense of the country attacked.

Notes on the War

A Paradox of Sea Power.—Writing in *Land and Water*, A. H. Pollen states that it is one of the paradoxes of the present war that the possession of an invincible navy, instead of freeing Great Britain from military obligations, has placed them upon her shoulders. He points out that so absolutely has the enemy accepted the British sea supremacy, that she has lost both the advantages and disadvantages of her insular position. "So far," says he, "from our great fleet having relieved us of the duty of maintaining an army proportionate in strength to itself, it is precisely the fleet and nothing else, which, by enabling Great Britain to use such a force, has imposed upon her the burden of creating it."

German Armed Merchantmen.—The German auxiliary cruisers (armed merchantmen), gave a good account of themselves in the early stages of the war—that is, such of them as were at sea or managed to leave port before the Allied Navy had full control of the seas. Had it not been for the suddenness with which the war came, and the complete mobilization in which it found the British Navy, the armed cruisers of Germany would have been abroad on the high seas in greater numbers and in a state of very complete equipment. In an account of the "Carmania's" duel with the "Cape-Trafalgar," sent to the German press by one of the survivors of the German ship, he stated that if "our heavy guns had been on board, we should have given the Englishmen a shock." The same writer refers to the 4.1-inch guns on the "Cap-Trafalgar," from which it is fair to presume that the "heavy guns" which should have been on board were at least of 6-inch calibre.

Enveloping the Russian Army.—Since the great German-Austrian drive commenced in May, the Central Powers have made five determined efforts to envelop and break up five several great sections of the Russian army; and in each case they have failed. According to Belloc, the first of these was the attempted envelopment of the Russians at Przemsyl; the second occurred three weeks later before and around Lemberg; at the end of June the attempted envelopment at Warsaw began, and the whole of July was occupied with the endeavor to envelop the Russian army within and around this city. The Russians escaped absolutely intact. The fourth attempt was created around Grodno, and by the first days of September the Grand General Staff realized that this effort also was abortive. The fifth enveloping movement came very near being successful when a great mass of cavalry, estimated at forty thousand, pushed down from the north to cut the communications of the army at Vilna. Here, also, the Russian Generals withdrew their forces, practically intact.

The Freedom of the Seas.—A hint as to what the Germans mean by the "Freedom of the Seas," was contained in a statement made some time ago by the German Imperial Chancellor, that "the peace for which we are striving will guarantee to all nationalities the freedom of the oceans, and will offer possibilities to every nation of serving in the work of progress and civilization, by means of a free world-wide commerce." Germany, who has spent about one and one-half billion dollars in creating her fleet and its accessories, has found that this fleet is unable to protect its merchant marine, with the result that the German exports and imports amounting in the total to some five billions of dollars annually, have practically ceased, the ships of her vast merchant marine, being denied the "Freedom of the Seas." The question arises, had the conditions been reversed and had the German fleet possessed the preponderance over the Allies' fleet which the enemy now holds, would Germany to-day be maintaining the "Freedom of the Seas" for the benefit of the British and French sea-going commerce carried in British and French bottoms, or under the flag of neutral powers?

Damage to the "Lion" and the "Tiger."—The Germans have persistently claimed that the battle cruiser "Tiger," of the British Navy, was sunk in the battle cruiser fight in the North Sea. The British have denied this, although they have admitted that Rear Admiral Beatty's flagship, the "Lion," was disabled and had to be towed home. That the "Tiger" was not lost is now established by the testimony of the well-known war correspondent, Frederick Palmer, who visited the British main fleet and was permitted to write an exceedingly frank article about what he there witnessed. He saw the "Lion" and the "Tiger," and he tells us that the former was hit fifteen times, and the "Tiger" eight times in the Dogger Bank fight. The turret of one of the ships was hit on the roof, but only a small fragment passed through, resulting in the temporary disablement of one gun. Another shot passed through the side of the ship and burst, the fragments striking the barbette harmlessly. The description of what he saw is contained in the last issue of *Collier's* and is extremely interesting and shows that "all's well" with the British main fleet.

Electricity

A New Telautograph has been invented by two Swedish engineers, according to a report of the United States Consul General at Stockholm. The new apparatus apparently differs entirely from the fundamental principles of the telautographs now in use, for it can be operated independently of the resistance of the line. It can be connected to either a short or long line without adjustments of any kind; this advantage making it available for use over ordinary telephone lines.

Construction of Four Standard Ohms.—The United States Bureau of Standards has just issued a paper (Scientific Paper No. 256) dealing with the construction of four standard ohms. This unit was defined by the London Congress as the electrical resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14.4521 grams in mass, of a constant cross-sectional area and of a length of 106.300 centimeters. The work done at the Bureau of Standards consisted in the construction of material standards representing the unit realized in the form of mercury columns in glass tubes, and the work involved measurements of the highest accuracy of the length, the departure from uniformity of the cross section, and the mercury content of each tube, as well as their comparison with a working standard. Electrical comparisons of the four standards showed the average deviation of their individual values to be less than one one thousandth of an ohm.

Odd Electrical Heating System for Homes.—A Swedish inventor has devised a most unique system of electrical heating for houses of from four to ten rooms and which is especially intended for localities where electric current is inexpensive. The system consists of two tanks, a motor-driven rotary pump, and the necessary radiators and piping. One of the tanks is placed in the attic of the house and is thermally insulated. In it are placed the heating units which, normally, are only operated at night when the rates for electric current are low. In the morning the heating units are disconnected from the supply circuit and the motor-driven pump started. The water flows down the piping and through the radiators by the force of gravity and is collected in a receiving tank in the basement, from where it is pumped out and returned to the tank in the attic. It is claimed that the cost of heating a house by this system is about 12 cents per room, with a current rate of 1 cent per kw. hour.

Electric Transmission Cables of Aluminum with Steel Cores.—The substitution of aluminum for copper in transmission lines has been a subject of paramount interest to engineers and electric power interests. While aluminum is considerably cheaper than copper in a cable of given length and resistance, its lower tensile strength necessitates the employment of shorter spans and a greater sag, hence more and higher poles or towers are required. Thus the saving that is effected in the cable proper is practically cancelled by the increased cost of the supports. However, the difficulties of using aluminum cables economically have recently been apparently overcome by the combining of a steel core with an aluminum covering; the former furnishing the necessary tensile strength and the latter conducting the electric current. The steel core may be made either of a single wire or of several strands, while around it are wound the aluminum strands. Since the greater part of the current passes through the aluminum covering, a choke coil effect obtains in the cable, adding reactions to the line and giving rise to hysteresis losses. To a great extent the former is cancelled by the conducting power of the steel core, but data relative to the extent of the latter are not available at present.

Telephoning by Wireless Across the Atlantic.—It is announced by the American Telephone & Telegraph Company that on several different occasions during the past two weeks its engineers have succeeded in transmitting clear, understandable speech across the Atlantic Ocean, between the United States Government station at Arlington, Va., and the Eiffel Tower station at Paris, France, a distance of some 3,800 miles. It is understood that the same apparatus was used as that employed in the recent Arlington to San Francisco and Hawaii tests. The present feat—although it was generally believed to be within the range of immediate accomplishment since previous tests demonstrated the possibilities of covering greater distances under less favorable conditions, in traveling from Arlington to San Fransico and Hawaii the waves passed over some 2,500 miles of land and a number of tall mountain ranges—has caused much surprise. The Eiffel Tower station is a military establishment and handles a great volume of traffic between the seat of the French government and the scattered forces of the republic, so that the use of the station at this time for the experiments was hardly believed probable. However, the engineers were permitted to use the station at certain intervals and for only a few moments at a time, which naturally made the conditions of the tests most difficult.

Astronomy

"Spy Rockets."—England's anxious lookout for the activities of spies extends to the heavens, where rocket-like meteors have several times been reported by special constables as "spy rockets." One of these bodies formed the subject of a telegram in which Mrs. Fiametta Wilson, the well-known meteor observer, asked another meteor observer, Miss Cook, whether she had seen it. The telegram was held up by the censor, but subsequently allowed to pass.

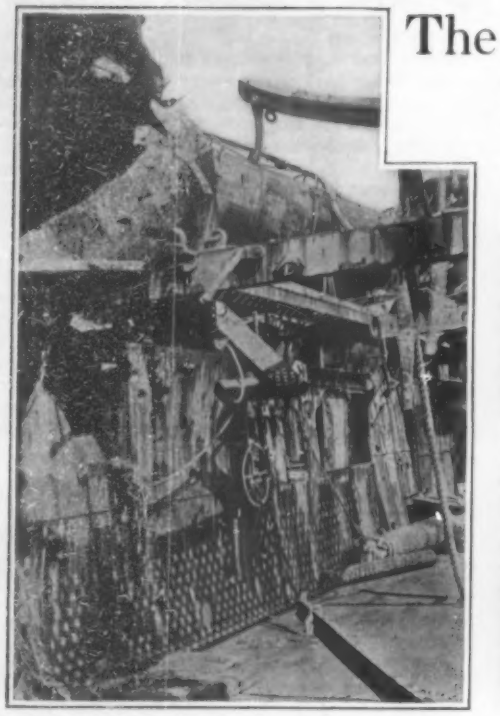
Prof. Dr. O. Lohse, whose death was recently announced, was principal observer at the Potsdam Astrophysical Observatory, and had been prominently identified with the work of that famous observatory from its foundation. In his earlier years Lohse was Vogel's assistant at Bothkamp, where he took part in the latter's epoch-making work in spectral analysis and celestial photography. He is, however, best known to astronomers for his researches at Potsdam on the physical conditions of Mars and Jupiter.

The Rotation Period of Neptune is unknown, as there are no visible markings on its surface by means of which this period can be determined. However, as long ago as 1883 Mr. Maxwell Hall, of Jamaica, observed fluctuations in the brightness of the planet, as compared with that of two stars in the same field of the telescope, and comparisons extending over a fortnight led him to assign a period of about 7 hours 55 minutes as the interval between successive maxima of brightness, and hence presumably as the planet's rotation period. During the last opposition of Neptune, Mr. Hall made more elaborate photometric measurements. He found the normal magnitude of the planet to be 7.67, with fluctuations having a range of about 0.6 magnitude. His latest estimate of the rotation period is 7 hours 50 minutes 6 seconds. He now urges observers in various parts of the world to make photometric measurements during the 1916 opposition of the planet; especially towards the end of March and the beginning of April, when Neptune will be nearly stationary.

The Colors of Meteors.—An interesting article by Alfred Wegener offers an explanation of the marked difference of color observed in meteors. Up to an altitude of about 45 miles the principal constituent of the earth's atmosphere is nitrogen. A second stratum of the atmosphere, extending up to about 125 miles, consists mainly of hydrogen. Still higher Wegener himself has sought to prove the existence of a stratum consisting of an excessively light gas which he calls "geocoronium." When entering the atmosphere from outer space meteors do not become luminous in the very tenuous "geocoroniumsphere," but only when they enter the "hydrogensphere," and most of them are dissipated before reaching the nitrogen atmosphere. The largest fireballs, however, penetrate deeper, and may reach the earth or explode not far above it. Dr. Wegener finds that the meteors that penetrate deep enough pass through three color stages, viz., yellow-white, green, and deep red. The great majority exhibit only the first stage, in which the color (white, yellow, sometimes reddish) is that of the incandescent meteor itself. The green stage Wegener believes to be due to the incandescence of the hydrogen through which the meteor is passing, while the deep red stage is due to the incandescence of nitrogen in the lower atmosphere.

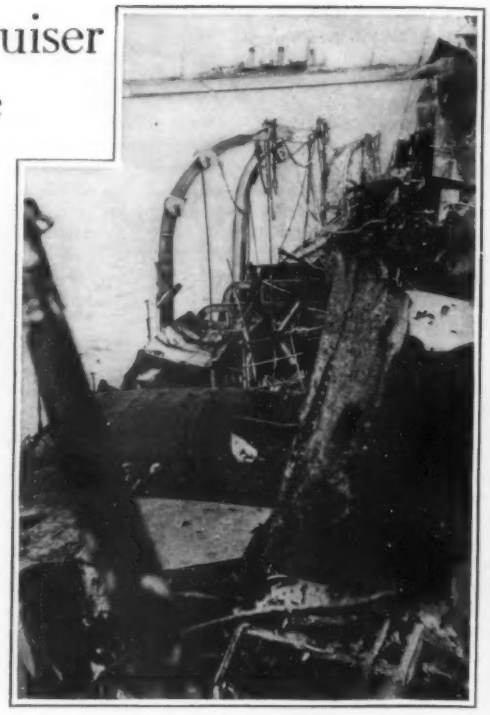
The Rotation of Ganymede, the third satellite of Jupiter, is discussed in a recent paper by Mr. W. H. Steavenson, who urges observers to take advantage of the present favorable position of Jupiter and his system to make further investigations on this subject. Ganymede presents to us a larger disc than does any other satellite in the solar system except our own moon. Its disc is, of course, very small—about 1 inch.15—but is nevertheless large enough to enable us to observe markings upon it under favorable conditions. These take the form of dusky streaks and patches, and at least three appear to be of a permanent character and can be identified with reasonable certainty. One of the three is especially interesting. It generally takes the form of a dark shading extending along the north-following limb, giving the satellite the appearance of a phase about equal to that of the moon when nine days old. Strangely enough, this shading is never seen to transit the disc completely, so as to cause a similar apparent phase on the opposite side. It has been suggested that "there is probably a meridian zone of matter, which gets black in the absence of sunlight, but which is rapidly altered and becomes reflective when the sun rises on it." Mr. Steavenson finds evidence in the observed movements of another of the three markings that the satellite has a rotation period about 59 minutes shorter than its period of revolution about the primary.

The Wrecking of the Cruiser Emden by Shell Fire



Superstructure and fallen smokestack

Wreck of the bridge



Shell-torn deck and smokestacks

IT is not often that the world has an opportunity to judge for itself of the terrific destruction wrought by accurate shell fire in a modern naval engagement; certainly, we have never presented in these columns an after-the-battle photograph of the beaten warship, which showed in such dramatic fashion the frightful execution which well-directed shell fire can do upon the hull, decks and superstructure of a light cruiser. The "Emden," it will be remembered, was the most successful of those fast German cruisers, which, in the earlier months of the war, preyed successfully upon the merchant shipping of the Allies. Her displacement was 3,600 tons and her best speed, 24½ to 25 knots; although it must be remembered that, due to her long cruise at sea, her bottom when she fought her last engagement was foul and her speed therefore was considerably reduced. She was protected with a 2-inch deck amidships and carried an armament of ten 4.1-inch guns. While she was engaged in raiding a British wireless station on an island in the Indian Ocean, the Australian cruiser, "Sidney," warned by the wireless operators before the Germans had a chance to destroy the plant, had rushed at full speed to intersect and engage the German ship. The "Sidney" is a light cruiser of 5,200 tons displacement and 26 knots speed, mounting a battery of eight 6-inch guns.

The "Sidney," at the time she received the call for assistance, formed part of the convoy for a contingent of the transports carrying Australian troops to the Dardenelles and Egypt. As she approached the island her smoke was discovered by the "Emden," which immediately steamed out into the open, not even waiting to pick up a large landing party that had been sent ashore. This party, by the way, subsequently seized a schooner, made its way over to the Arabian coast, and finally turned up in Constantinople after a series of adventures which for romantic daring the most imaginative novelist would find it hard to equal. The "Emden" concentrated a very accurate fire on the "Sidney" during the early stages of the engagement, but the "Sidney," taking advantage of her superior speed and the greater ranging power of her guns chose to fight a long-range action, during the course of which she cut the German cruiser to pieces and fairly decimated her crew. Captain Muller, of the "Emden," realizing that his ship was done for, headed for an island and beached the "Emden" and only hauled down his flag after he had received further broadsides from the "Sydney."

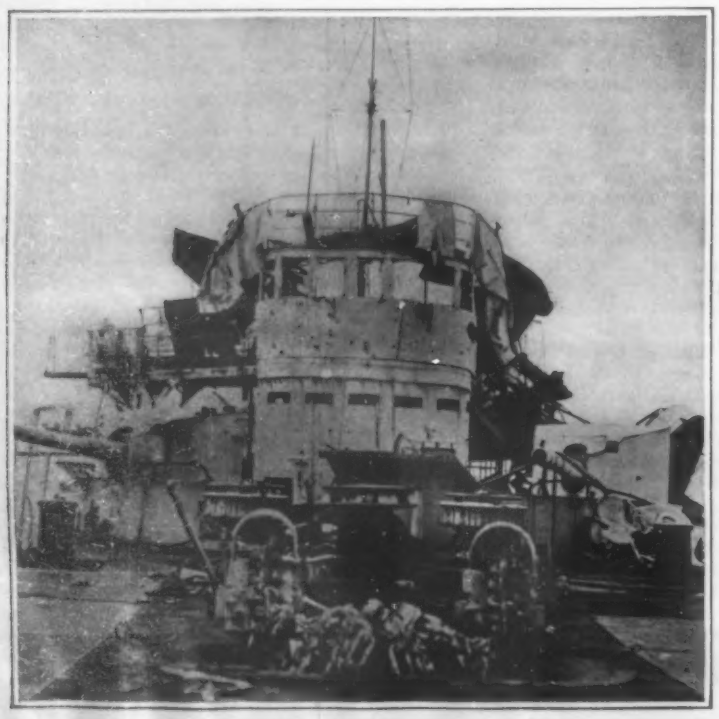
The photographs of the wrecked vessel speak for themselves and testify to the hurricane of high-explosive shells which found and searched out the doomed vessel. They show what the 100-pound shell can do, when it is directed against unarmored plating. Judging from the multi-perforated condition of such structures as the bridge, the fragmentation of the shells must have been perfect, and it is marvelous that any of the officers and crew escaped. Moreover, whenever the shells burst in confined spaces, the pressure of the trinitrotolnol gases was sufficient to burst the whole structure open, as will be noted in more than one of the photographs.

The victory of the "Sydney" naturally aroused great enthusiasm in the young Australian navy, and a wrecking crew is being dispatched to raise the "Emden" and bring her to Australia as a notable trophy of the war.

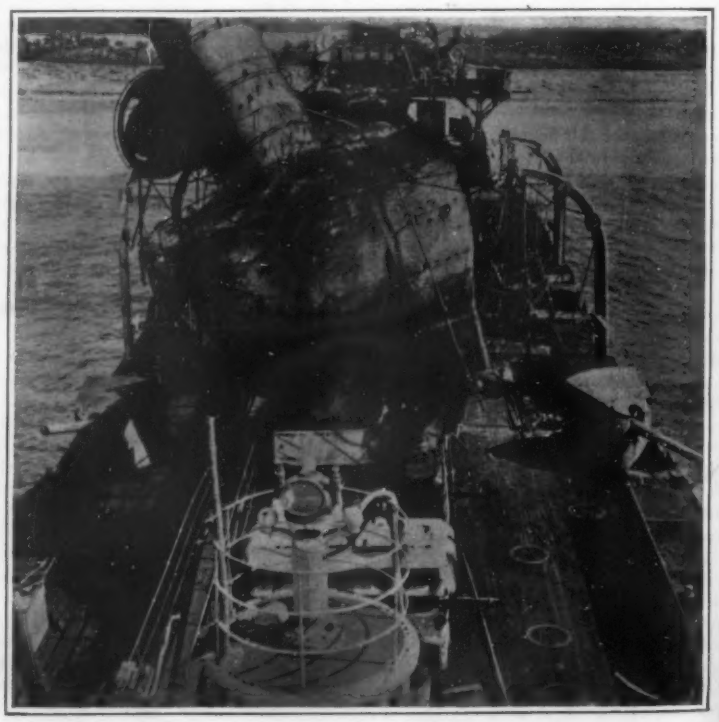
Charcoal Plates for Insulation

A NEW insulating material has been extensively used in Germany, lately, to take the place of cork. This is composed of wood-charcoal mixed with paper pulp and pitch or tar. The wood used is refuse composed of the small scraps from various industries. The plates of wood-charcoal are obtained by a patent process and are offered commercially under such names as wood-charcoal-plates, wood-charcoal-stone, wood-charcoal-boards and iris-bodies.

They are said to be not inferior in insulating qualities to the well-known cork-stone-plates. Since the German railways offer attractive freight rates for this new insulating material, it is able to compete successfully with the cork-stone-plates. Current prices, according to the *Chemiker* Zeitung, which quotes from the *Zeitschrift für Dampfk. Betr.*, are 19-23.75 marks per 100 kilograms for the charcoal-plates, 15-26 marks per 100 kg. for cork-stone-plates, and 19-35 marks per 100 kg. for cork-stone-boards.



Looking aft from forecastle deck



View looking forward

Aerial Range-Finding with Electrical "Ears"

A Microphone System of Detecting Invisible Airships and Determining Ranges

NO longer do German airships undertake raids over the territories of their western adversaries during daytime and in clear weather. The dirigible pilots know too well the vulnerability of their huge craft to the hurricane of fire from thousands of anti-aircraft guns that dot France from the wavy western battle line to Paris, as well as those that guard the coasts and interior points of England. And the danger to them is not confined to anti-aircraft guns, for there are the squadrons of fast, heavily-armed battle-aeroplanes to contend with, which rise in virtual swarms to give battle to the more cumbersome air-cruiser.

The opening month of the war witnessed the unsuccessful and somewhat costly efforts of the Teutons to employ their Zeppelins in daylight for the bombardment of fortresses, camps and cities, and as participants in military engagements. The second month, September, saw the practically total abandonment of daytime raids on the western front; the German pilots evidently having decided that their air-cruisers could be used to far better advantage and with almost complete immunity from gun fire and aeroplane attack when employed at night, in foggy weather, or when low-hanging clouds offer an effective screen behind which Zeppelins can navigate without being observed.

The protection that airship pilots have thus availed themselves of is but a temporary respite; for although they may be invisible to observers on the ground, they are not noiseless. The sounds of the engines and propeller blades can be detected and amplified with suitable devices, serving to betray the presence of an airship; and developing these systems to a still finer degree, it has been rendered possible even to determine the range of the unseen airship for setting the fuses of the anti-aircraft shells and adjusting the aerial guns.

The anti-aircraft defenders of Paris have devised an ingenious airship detector which they call a *poste d'écoute*, or listening station. It is in the form of four huge horns or reversed megaphones so mounted as to swing on a pivot to any point of the compass and turn on bearings to any angle in relation to the ground. The horns all point in the same direction and because of their huge size are capable of gathering the slightest sounds. These are then magnified by means of microphones. An operator, swinging the horns in all directions and listening carefully to the sounds gathered by the device, can detect the presence of an airship at a considerable distance away, even if it be high in the air and behind dense cloud banks. It is also possible to determine the approximate position of the invader and dispatch a squadron of aerial defenders to rise among the clouds and give battle to him after he has been found.

Whereas the French airship-detector only serves to betray the approach of hostile aircraft, there has been developed in the United States a system for detecting as well as determining the exact position of hostile airships, making it possible to furnish anti-aircraft gunners with the range of the invisible target. The system, which makes use of telephone microphones in an ingenious manner, is the invention of Edward F. Chandler of New York, whose work in torpedo design has been extensive.

This airship detecting system consists essentially of placing telephone microphones at the corners of a geometrical figure which may be in the form of a triangle or a parallelogram of known size, and adjusting these microphones until the sound waves from the aircraft are loudest; the microphones then aiming towards a common point which is the position of the airship. Mathematical calculations then permit the determination of the distance between the common point, or apex, and the ground, giving the range to the gunners.

In its simplest form, and that which will be used in temporary installations in the field, each microphone is placed at the base of a large horn, which in turn is mounted by means of a gimbal-ring construction—similar to the mounting of marine compasses—on a heavy service tripod. A microphone is placed at each corner of an imaginary triangle or parallelogram of known size, and an operator detailed to each microphone. The operator, wearing a telephone headset, slowly moves the horn about in all directions until sound waves caused by airships are detected. The horn is then adjusted until it points straight at the source of the sound waves, which is determined by the loudness of the sounds. As the aircraft moves the horn is also moved, and when the target passes within effective range each operator—who in the meantime has been adjusting his microphone, so that they all point towards a common center—signals the readings of his instrument to the gun pointer. By combining the different angles and directions at which the microphones are pointed, the gun pointer can arrive at the apex of an imaginary pyramid or cone, and it is then but a simple mathematical problem to determine the distance between the apex and the ground, which is the range sought. In the accompanying illustration, x indicates the range that is determined for the gunners. To facilitate the calculations, a special form of slide rule is employed so that the determination of the range is greatly simplified and occupies but little time.

In installations of a permanent character, such as those for the protection of fortresses and cities, the detector system is more elaborate and necessarily more complicated. The essential principle remains the same: the microphones are mounted at the corners of an imaginary triangle or parallelogram of known size. However, this system requires but one operator who is located at some suitable point which may be remote to the zone of the detector system if desired. The microphones are governed by the operator through a remote control system which makes use of differential resistances and magnets and is similar in principle to the Gray telautograph mechanism which transmits facsimile handwriting over wires.

Arrangement of microphones for detecting and locating aircraft

The operator listens by means of the telephone receivers worn on his head to the sound waves striking each microphone; the microphones being constantly turned in all directions so as to cover the sky that comes within the zone of the installation. When the sounds of an airship are picked up, the microphones are each adjusted until the sound is loudest in the telephones. In order to lend greater accuracy to the comparison of the sound volume of each microphone with the other microphones, the human ear is replaced by an electrical device permitting of more accurate results. Briefly, the electrical device may be described as twin galvanometers placed end to end so that the needles of both instruments point towards each other. In installations using four microphones, the duplex galvanometer comprises four windings; two of these acting on one moving member pivoted between them and the other two acting on another needle mounted in the same manner. Thus the magnetic fields, created by the currents passing through the four microphones, exert their influence on the moving needles in direct proportion to the strength of the current. When the currents passing through two microphones connected to the coils of one galvanometer are equal, the needle remains in the center position, indicating that balance obtains in both circuits. On the other hand, when the current in either microphone circuit increases or decreases, the balance is disturbed and the needle moves to either side.

After the sounds of an airship have been picked up on each microphone of the system, the operator switches the sound detectors on to the galvanometer device and makes the final adjustments of the microphones, carefully watching the needles until they both point to 0 and towards each other. This, then, indicates that each microphone is equally affected by the sound waves and accordingly pointing towards their source, which is the target sought. An instant's work with a slide rule results in determining the distance between the apex of the imaginary cone or pyramid formed by the known distances between the microphones and the direction in which they are pointing towards the common point, and the ground. This information is then telephoned to the anti-aircraft artillery, as well as to the aeroplane squadron commander, if so desired.

Since aerial artillery does not require the exactitude demanded by military and naval range finding, the distance of the target from the ground is sufficient for the determination of the range. The shells are usually in the nature of shrapnel and upon exploding scatter fragments over a wide area, so that the main requirement is to time the fuse of each shell so that the explosion will occur on the same level and as near to the airship as possible.

The microphones, in conjunction with suitable amplifying apparatus, are capable of picking up airship sounds several miles distant, and while the operator then adjusts his microphones to point towards the moving target—using only one or two microphones for this purpose since there is no object to be gained in using the others at this time—he makes no attempt towards the final adjustments until the airship passes within the effective zone of the installation. The microphones follow the moving target much in the same manner as a pair of eyes; a skilled operator being able to move them in perfect unison. There is no hard and fast rule for the most suitable shape and size of base figure to use with this system. The microphones can be spaced several hundred yards apart; and the inventor states that for determining ranges up to 5,000 feet, a spacing of 300 yards between microphones is ideal.

Recently, Dr. Lee De Forest, perhaps best known as the inventor of the audion wireless detector, the audion amplifier and the audion high frequency generator, left New York for England on the mission of installing an airship detector system for the protection of London against Zeppelin raids. As far as can be learned at the present moment, the De Forest system also makes use of a number of microphones placed in a geometrical figure on the ground. The audion amplifier is employed to magnify the received sound waves and thus increase the range of the apparatus. By adjusting the different microphones so as to obtain the loudest sound from each, the microphones point towards a common point, which is the apex of a cone, and make it possible to calculate the target's range.

The Current Supplement

THE current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2078, contains an unusual variety of matter of interest to the general reader who desires to keep up with recent advances in science and arts. An article on the sidereal universe is an admirable résumé of the present situation in the science of astronomy, and progress made in the more important problems. The difficulties apparent in repelling aeroplane attacks with guns is evident, and some of the problems are discussed, with explanatory diagrams. Economy of fuel is a subject of increasing importance. Some of the efforts in the direction of utilizing exhaust steam are described and illustrated. An important matter to take into consideration when laying out any large manufacturing plant is ventilation. Vitiated air has been found to exhaust the energies of the workmen, and greatly reduce their productive ability. A solution of the problem in a great factory is described and illustrated. An interesting feature is a description of a great metal press used in automobile building.

Shellac is such a common article that we seldom stop to think where it comes from. An unusually interesting article gives a fund of information about the little lac insect with descriptive illustrations. The trend of electrical development, and the limits of efficiency is discussed. There is also an article illustrating and describing some methods employed in building trenches on the battle front in Europe. An interesting comparison of our earliest locomotive and one of modern times illustrates some notes on pioneer engines. The situation in regard to the manufacture of chemicals in the United States is attracting much attention, and the review of the subject in this issue covers the matter in a comprehensive manner that will be appreciated. The article on electricity in agriculture is concluded, and there are articles on features of road construction and other interesting subjects.

Strategic Moves of the War, October 21st, 1915

By Lieut. J. B. W. Gardiner, Formerly of the 11th Cavalry, U. S. A.

INTEREST in the Great War is still centered on the situation in Serbia created by the Teutonic invasion of that state and the entrance of Bulgaria on the Teuton side. Russia, France, England and Italy, in the order named, have formally declared war on Bulgaria so that the combined efforts of the entire Quadruple Entente will probably be thrown into the near eastern theater to thwart the Teuton plans. There is a tendency on the part of foreign correspondents to regard the Balkan situation as one fraught with the greatest danger to the Allies' cause. So important indeed do these correspondents make out the newly created situation, that if future developments of diplomatic or military events go in the slightest degree further against the Allies, the latters' situation will be truly desperate and the whole fortune of war will probably go against them. Before taking up the military campaign in this theater as it has developed since October 14th, the date of the last review that has appeared in these columns, it may prove interesting to analyze briefly the situation as a whole to see just what justification there is for this point of view.

In the first place certain facts are of such common knowledge that there can be no dispute. The available man power still remaining as a potential reserve is much greater with the Allies, as they are at present constituted, than with the Teutons. The Teuton wastage through casualties is, on the Russian front, somewhat less probably than the Russian, but on other fronts is, with equal probability, greater. This does not mean the rate of wastage based on the relative numbers of men engaged, but the actual numerical losses. Again, the Allies have unquestioned financial superiority. British commerce is practically unmolested. In spite of the German submarine activity, over 98 per cent of British and French vessels, inbound or outbound, reach their destination and discharge their cargoes. Germany's commerce is totally destroyed, so that everything Germany buys abroad (and she is unquestionably getting some supplies through neutral ports) must be paid for not in an exchange of merchandise, but in cash, and she must in addition pay for the supplies produced at home with cash drawn entirely from her internal resources. In shell production it is possible that Germany may have at present a certain superiority, but this superiority, if it exists at all, is fast disappearing. Through British control of the seas, the Allies have the markets and factories of the world at their command. Enormous contracts have been let in this country, deliveries under which are just beginning to reach material proportions. Soon the pendulum will swing the other way and in shell supply also the advantage will rest with the Allies. These three things —man power, money and shell—are the all-important factors in modern war and they cannot be offset by the more perfect German organization. The effect of the Allies superiority in these factors has been amply demonstrated in the past month both in France and in Russia. Last winter the Allies began a determined offense in Artois and in the Champagne. In Artois the fighting was particularly desperate for possession of Loos with the surrounding hills which dominated both the city of Lens and the approaches to it. In the Champagne the fighting was directed against the German positions on the hills, just behind which ran the Challerange-Bazancourt railroad, the connecting link between the German army in the Argonne and that in the Champagne. In both cases the French offense, though lasting for several months, was unsuccessful and gradually subsided. Nine months later, through superiority in shell and in men, at least at the points of attack, the Allies accomplished in three days what they had failed to accomplish before in three months. The German line in the west is thinning out, not to the point where it can be broken and penetrated over a wide front, but to the point where it can be deeply indented. The most favorable aspect of the case that the Kaiser can possibly see, is a stalemate. He cannot go ahead, he might possibly keep the English and French in their trenches. Ultimately, unless a decision can be gained in the east, this must mean victory for that side which possesses the greater resources—in this case, the Allies. This transfers attention to the Russian front.

Two months ago the Russians seemed shattered, their organization disrupted, their inferiority in shell so marked that to check the rush of the German advance that started in May from the Dunajec River seemed an impossible task. The Russians were apparently trapped time after time only to escape capture or annihilation through the extremely clever strategy of the Russian commander. Suddenly the German advance was halted, the Russians seized the initiative and striking back along the entire line from Riga to Bessarabia, succeeded in straightening out their line and held the Germans absolutely in place west of the railroad from Riga to Rovno. There is but one possible answer—men and shell. As for the latter, Russia has through double-tracking the Trans-Siberian road increased her supply or the Germans through lack of a lateral communication have of necessity decreased theirs. The result is the same—an equality of artillery which narrows the proposition down to one of individual rifle fire—which is to the number of men. And in man power Russia is superior.

It is on the eastern or the western front that the war will be won. It is inconceivable how it could be otherwise. The Teutons may create a situation in the Balkans, in fact have done so, which appeals strongly

Map of operations in the Balkans

to the imagination. The conquest of Serbia will be a dramatic triumph but will not prove a military decision. It will merely put ahead the day of peace rather than bring it nearer. Popular interest, however, is stirred largely by events that have an imaginative appeal particularly when there is a strong dramatic element. Therefore the interest of the public is still centered on the Balkan situation.

The development of the Teuton-Bulgar offensive has a number of points of interest. The Teuton plan has not varied in its general conception from that which was indicated in the first stages of its development. The front of advance is over the full northern boundary of Serbia, but particularly between Belgrade and Semendria. The operations east and west of these cities are altogether subsidiary, as it is this front which holds the key to the railroad situation. The strongest concentration of effort is therefore on the direct drive to Nish, while the flanks of the army making the drive is guarded by the troops east and west.

The Bulgarian part in the campaign has, however, undergone a change from the plan that was indicated by the initial moves. At first it seemed that the drive both of the Teutons and the Bulgars would be at Nish where the Berlin-Constantinople railroad is joined by the railroad from Saloniki, over which the Allies were to send Serbia assistance. Bulgaria, however, while a comparatively small portion of her forces are so engaged, has taken for her principle immediate objective the Saloniki-Nish part of the line in order to prevent assistance from reaching the hard pressed Serbians. This line comes closest to the Bulgarian frontier at Wanja—about 50 miles south of Nish and in the valley of the Vardor Rivere—where in some places it is not more than five miles distant. The Bulgarians have reached Wanja and have struck against the southern part of the line also. This means that they have thrown the Saloniki railroad completely out of use so far as any allied aid reaching the Serbians in the north is concerned. It is therefore apparent that most of the fighting in which the Allies are engaged must be against the Bulgars and this has proven to be the case. As is always the case at the beginning of a campaign, reports are so at variance that it is difficult to form any definite idea as to individual moves. There is an irreconcilable conflict that will not be settled until the entire campaign has assumed more positive shape.

It would seem to be the general plan of the Bulgarians, once the Saloniki-Nish railroad is cut, to clear it as far north towards Nish as possible so as to make a junction with the Austro-German forces coming from the north. The Allies on the other hand would appear to be attempting a flanking movement against the whole of the Bulgarian line. This is the object of the attack on Strumitza—the strongest fort in southwestern Bulgaria and on which Bulgaria would naturally depend for one of the bulwark defenses of her left wing.

The Allies have also increased the possibilities of the situation by landing a force at Enos and seizing the Bulgarian railroad which connects with the seaport of Dedeagach. The object of this move would seem to be the town of Dimotika, the junction point of the Berlin-Constantinople road with the main road from Greece to Constantinople. Although in order to make such a move feasible the force would have to be very large as it would be between two hostile countries, Turkey on the east and Bulgaria on the west. However, once at Dimotika, the Allies would have an excellent opportunity to strike either for Constantinople or Sofia. One result that this landing is sure to accomplish, however, is the diversion of Bulgarian interest from their western front, where they are driving at the Serbs, to their southeastern border, where their short coast line is on the Ægean. It would create an exceedingly interesting situation if the Allies would withdraw from Gallipoli at least in part, and with Italy's aid land a force of sufficient size to move against Constantinople in an effort to reach that point before the Teutons and Bulgars can clear the railroads in Serbia. This could be done from Enos in two ways. First, by way of Demotika, following the valley of the Maritza River and the general railroad line, and, second, by striking not at Constantinople directly, but at Gallipoli from its eastern end. An excellent dirt road runs from Enos eastward to Kavak where it is joined by the main road through Gallipoli, about 12 miles east of Bulair. With the help of the fleet in the Gulf of Saros an army operation along this line could be much more readily supplied and reinforced than if the much longer railroad route were taken. But this of course is speculation. No indication has yet been given as to which way the force at Enos will move. Probably by the time next week's article appears the Enos movement, if it has any serious import, will have taken definite shape.

Predicting Volcanic Activity

DIRECTOR T. A. JAGGAR, JR., of the Hawaiian Volcano Observatory, has worked out an elaborate hypothesis in regard to the principles underlying the periodic outbreaks of Kilauea and Mauna Loa, with a view to making approximate predictions of these phenomena. This hypothesis takes account of the seismic and volcanic histories of the two volcanoes and the tidal and other stresses set up in the globe by the sun and moon, varying with the positions of these bodies. A prediction that Mauna Loa would have a summit outbreak between 1911 and 1915, occurring about June or December, was verified in 1914. Dr. Jaggar now predicts a lava flow from Mauna Loa, probably within four years and most probably in not less than three years, and the occurrence of a short-lived summit outbreak before the flow, most probably in January or July, 1918. He also predicts that the lava flow will break out from a vent on the north side of the mountain, probably somewhere above the Dewey Crater of 1899. In order that the expected period of activity may be properly studied he is endeavoring to raise a fund of $6,000, to be spent in establishing suitable stations and camps on Mauna Loa.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Beriberi-Preventing Vitamines

To the Editor of the SCIENTIFIC AMERICAN:

For two years I was engaged in beriberi investigation work in Manila at the time the existence of vitamines was first becoming recognized, and I was therefore much interested in the abstract of Dr. Reinhardt's article appearing in the September 11th, 1915, number of the SCIENTIFIC AMERICAN. Your editorial remark that some of Dr. Reinhardt's statements do not hang together is undoubtedly due to the too general and sweeping conclusions drawn in this abstract. The statement that "vitamines are destroyed partially by drying, and more completely by cooking" is incorrect if applied to all vitamines. There can be no doubt that there are several different chemical combinations, each of which is now classed under the heading of "vitamines." These different vitamines are not equally susceptible to the influence of heat, and perhaps of drying. It is well known that the vitamine concerned in preventing infantile scurvy is destroyed by simply boiling the milk for a brief period, and very probably is destroyed or impaired by the temperature commonly used in pasteurization (145 to 155 deg. Fahr.). What effect drying may have on it I do not know. The vitamine (or vitamines) which prevents beriberi is *not* destroyed by *ordinary* cooking. Fowls and men can subsist on boiled undermilled rice exclusively and remain free from deficiency neuritis. It has been proven that the beriberi-preventing vitamines are destroyed by heating to 120 deg. Cent., but this temperature is not reached in the ordinary cooking of rice, the boiling of peas or the baking of beans (both of which legumes are rich in vitamines). It was found, however, in Manila that the *prolonged boiling* for many hours of an alcoholic extract of rice polishings caused it to lose a part or all of its beriberi-preventing properties. There is reason to believe that canned foods such as meat, beans and peas may have been subjected to a heat sufficient in degree and duration to destroy in whole or in part the vitamines contained in these food substances.

As regards drying it can be said that ordinary drying in the air for a reasonable period does not destroy the vitamine concerned in preventing beriberi, since these vitamines are still active in dried beans, dried peas, dry peanuts, and in undermilled rice and rice polishings which have been kept for a long time under the atmospheric conditions of Manila.

As regards pellagra and rickets it is too early to draw conclusions as to the effects of heat, drying, and deterioration of maize, since it is by no means definitely proven that either of these two diseases is due to a vitamine deficiency.

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Vitamines and Cooking

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of September 11th, on page 238, I have just read the article called "The Vitamines and Their Importance for the Maintenance of Health," which asserts that "vitamines are destroyed partially by drying and completely by cooking." At the end of this article I noticed some editorial comment also stating that "vitamines are destroyed by cooking."

Your editorial comment further states, "There would appear to be little difference in food value between white bread and whole wheat bread or between boiled brown rice and boiled white rice as far as vitamines are concerned."

I do not know who your authority is for making this statement, but as the standard of the SCIENTIFIC AMERICAN is of the highest, I write you to say that this editorial comment on your part is not entirely substantiated by the scientific facts thus far developed regarding vitamines.

Casimir Funk has carried out a very complicated chemical investigation on rice and has isolated a substance which has occurred as a colorless needle-shaped crystal with a melting point of 233 deg. Cent. This is the equivalent of 451 deg. Fahr. Outside of the data developed thus far there is little known as to exactly at what point of temperature vitamines are destroyed. It is not accurately known that even melting destroys the vitamines at this temperature.

Funk has drawn several suppositions from his chemical investigations. One of these is that the vitamines are a constituent part of the nucleic acid which is present in the cells of food.

Another supposition which he has drawn from his investigations is that the vitamines belong to the pyramidine chemical base, but as to the assertions that vitamines are destroyed by cooking there has been few scientific data developed thus far.

It has been found that in some peculiar way the vitamines, when taken into the body cooked or uncooked in the hulls of rice, wheat and other food products, cooked or uncooked, are set free. In this free state it is supposed that they stimulate the secretions of the various glands, among them the thymus, the parathyroid and other internal glands of the body.

Through the secretions of these glands it appears that nutrition is influenced to a very healthful degree and we have therefore simply the hypothesis to go on that the vitamines have an indirect action on nutrition, and are not, so far as known, destroyed by ordinary cooking. It remains to be determined in a scientific laboratory at exactly what temperature vitamines are destroyed. Further than this, there are different kinds of vitamines. For example, yeast cells, milk, yolks of eggs, various kinds of meat and the germ of all grains contain vitamines. They are also widely distributed in animal and vegetable life, such as fresh green plants, juicy fruits, potatoes, etc.

You state that, "There would appear to be little difference in food value between white bread and whole wheat bread or between boiled brown rice and boiled white rice as far as vitamines are concerned." This has made me feel like taking the liberty to recount a personal experience of my own at Buena Vista, Cavita Province in the Philippine Islands, some years ago when I was in charge, as medical inspector, of a company of Igorotte soldiers affected very badly by beriberi.

At this time about one half of the company's troops were in the hospital suffering from beriberi, which is a disease affecting the heart and the nerves and which brings about great emaciation and great swelling of the limbs, ending ultimately in paralysis and death.

At the period during which I was put in medical charge of these troops, they had been eating the usual Philippine ration of rice which had been polished and which of course did not contain the hull.

At the same period beriberi had broken out like wild-fire among the Japanese troops during the Russo-Jap war, and the observation had been advanced at that time that those troops fed with the unpolished rice were not subject to beriberi.

This observation, at that time, had been widely heralded to us by Dr. Victor Heiser in command of health conditions in Manila. As no drugs brought results I tried feeding these troops unpolished rice with the astounding result that inside of six weeks time the beriberi sufferers had recovered sufficiently to take the trail and hike 15 miles to Manila.

This practical observation in the field of the Philippine Islands was further verified by a period of study covering one month's personal observation in the Japanese hospitals at Hiroshime, Tokio, Kobe and Sasebo, and when you said, therefore, that, "There would appear to be little difference in food value between white bread and whole wheat bread, or between boiled brown rice and boiled white rice as far as vitamines are concerned," I thought you had better become acquainted with this experience of my own which I will be very glad to talk to you personally about should you so desire.

Many of our present-day children are suffering from infantile scurvy which is due solely to the absence of the vitamines which should normally be present in the milk fed these infants, but which because of diseased cows and faulty sanitation are absent.

Another reason for scurvy is due to an unsuitable diet fed these infants which is chiefly starch containing no vitamines, which starch is the predomination base for many of the cereal breakfast foods and infant foods. It has been found that the nourishment of nursing mothers is often totally inadequate purely because of deficient vitamines in their milk.

Further it has been found that a diet poor in vitamines may lead to severe gastro-intestinal diseases and nervous disorders. Unfortunately we have much to learn regarding these very essential food constituents and the relation of the vitamines to disease has upset all our theories regarding caloric food values and become a factor of importance in our study of dietetics.

I do not want you to get the idea from this letter that vitamines are not destroyed by heat. The point I want to emphasize is that we do not at present know at what degree of heat is the danger or the destruction point.

Furthermore, what I have said regarding the treatment of the beriberi disease in the soldiers under my military command in the Philippines by the use of unpolished brown rice as a food value can be made to apply with equal force to the relative value of whole wheat bread as compared with white bread.

The absence of vitamines in foods leads to faulty nutrition, illness and death, and the time has come when it is no longer sufficient in dietetic treatment to merely consider the proteids, the carbohydrates and the fats which are the basis for the caloric theory of dieting.

The mineral salts and the vitamines are factors of equal importance to be remembered, and it remains to be determined by exhaustive scientific investigations how many different classes of vitamines there are and at what temperature each different class is destroyed by heat.

For your information let me add that the ordinary term called "extractives" contains among its many other ingredients the vitamines and in some exhaustive experiment in the University Children's Clinic at Breslau, conducted by Dr. Aron, he found that when young rats were fed upon such foods as butter, cheese, starch and wheat, from which the extractives had been removed, the animals rapidly lost weight and died.

On the other hand he found that when the extractives from bran were given these animals they immediately gained weight and thrived.

DONALD MCCASKEY, M.D.
Care Capt. K. T. Smith, Governors Island, N. Y.

Mathematical Coincidences

To the Editor of the SCIENTIFIC AMERICAN:

On reading Alfred J. Lotka's statement (SCIENTIFIC AMERICAN, Sept. 4), "The nearest approach to this (e) expressed as a common fraction using only 3 figures in numerator and denominator is $\frac{310}{114} = 2.7193$," it did not occur to me to doubt this statement. But when in a later issue (Oct. 9) Donald M. Liddell came out with a still closer ratio, viz.:

$$473 \div 174 = 2.71839$$
$$(e) \quad = 2.71828$$

and the statement, "There is probably a three-figure ratio still closer," my curiosity was aroused as to whether this was true, and as to how many such ratios there might be closer than either his or Mr. Lotka's result. I found by a fairly exhaustive method, that there are no less than *twenty-five* three-figure ratios as close or closer than Mr. Lotka's, and *four* that are closer than Mr. Liddell's. I give only the latter below:

Difference from e = 2.718282

$\frac{299}{110}$	= 2.718182	.000100
$\frac{492}{181}$	= 2.718232	.000050
$\frac{666}{245}$	= 2.718361	.000079
$\frac{878}{323}$	= 2.718261	.000021

For comparison Mr. Liddell's

$\frac{473}{174}$	= 2.718390	.000118

and Mr. Lotka's

$\frac{310}{114}$	= 2.719291	.001009

I should not call the latter even a good approximation. The error is ten times the poorest ratio given above and *fifty* times the best one. I was surprised to find the very simple ratio 299 ÷ 110, which may also be written 29.9 ÷ 11, gave such a good result, as any may verify without the need of pencil and paper. I did not have time to go over all of my figures carefully (I calculated carefully only those ratios that were very exact), so that my statement that there are twenty-five good ratios may be out by two or three, but in any case there are a good many of them.

Washington, D. C. M. MOTT-SMITH.

Railroad Safety Spurs

To the Editor of the SCIENTIFIC AMERICAN:

In an interesting article in your issue of August 28th, Mr. Harry Chapin Plummer described the safety spurs and their electrical and mechanical control, installed by the Baltimore & Ohio Railroad on the heavy grades betwen Altamont, Md., and Piedmont, W. Va., to safeguard the traffic over these grades, which average 2 per cent. He characterizes this installation as a safeguard unique in engineering practice, overlooking the fact that for years the Southern Railway on its Asheville Division has protected traffic on the heavy Saluda grade between Tryon and Saluda, N. C., by three safety spurs similar to this Baltimore & Ohio installation, although the signal control and other details may differ to some extent.

Further, the Asheville Power & Light Company of Asheville, N. C., which, by the way, is very ably managed by Mr. H. W. Plummer, has for some years protected the track to its park on the Swannanoa river by manually-operated switches and safety spurs, the conductor being required to unlock the spring switch, which is normally set for the safety, and hold it open until the car has passed, the switch springing back to position when the lever is released.

Stories are told of thrilling rides, of heroic conduct and of distressing fatalities on the Saluda grade before the installation of the safeties, but thousands of tourists and numerous trains of freight are now handled daily without accident or the fear of accident.

C. D. FLANIGEN.
ATHENS RAILWAY AND ELECTRIC COMPANY, Athens, Ga.

The Great Gas Tunnel Under the East River

A Battle with Floods Two Hundred Feet Below Sea Level

By J. F. Springer

THE story of the construction of the new Astoria-Bronx tunnel beneath the waters of the East River is one of romantic interest. This passageway has been excavated and finished for the purpose of providing suitable protection for two big gas mains. The gas will be made at Astoria, Long Island, and delivered by the mains into the Borough of the Bronx at 132nd Street and East River.

At one time, this tunnel for three fourths of its length, together with practically the whole of the Astoria shaft, was completely flooded. The water was scarcely removable by ordinary means; for the supply back of it was the great reservoir of the Atlantic Ocean. How it was lost and how recovered, completed and made safe constitute a stirring chapter in construction history.

The tunnel is the result of the great increase in population of the Bronx section of New York city and the advisability of manufacturing gas in a district more or less remote from the congested regions of the metropolis. In finished size, the tunnel is 19 feet wide, 18 feet high and 4,032 feet long. In cross-section, the tunnel resembles a horseshoe set with the rounded part above and standing upon a rather flat invert. It is large enough to receive two cast iron mains, either of them 72 inches in internal diameter, and provide a large space over them for future necessities. The tunnel dips slightly towards the Astoria end and thus provides for drainage. The average level is about 225 feet below mean sea level. Counting the Astoria and Bronx shafts, the total excavation is, accordingly, about 1 mile in length.

The axis of the tunnel does not deviate very far from a north and south line. The route passes beneath two channels 75 or 80 feet deep, located, one near the Bronx end and the other not far from the Astoria end. The geological formation changes at both places because of the intermediate occurrence of comparatively soft dolomite rock between Fordham gneiss. At the juncture on the Bronx end, the rock is greatly fissured and disintegrated. Here any amount of trouble occurred during construction.

Water streaming through grout holes left in the concrete lining. This photograph was taken eight months before the flooding of the tunnel

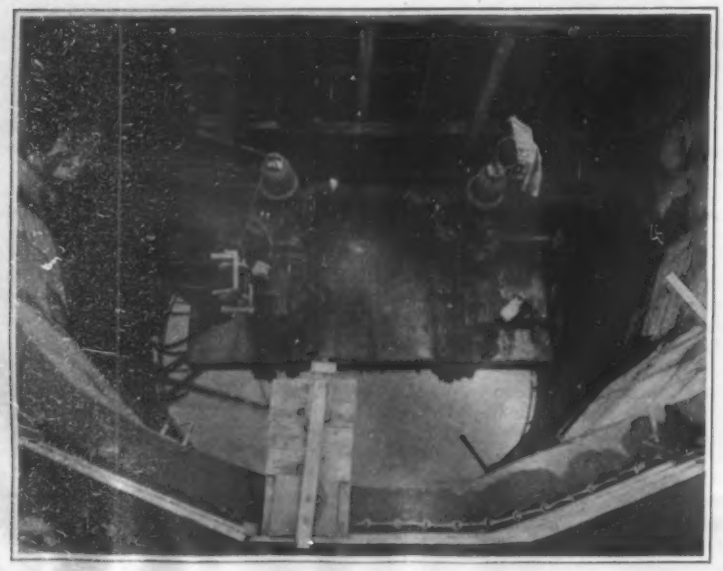
Water in the tunnel close to the Astoria shaft

In general, the tunnel is simply lined with concrete; but in the region beneath the Bronx depression in the river bottom cast iron and steel linings have been used to assist in meeting the conditions. However, the metal does not appear because of an inner layer of concrete. To an observer passing through, the tunnel seems to be lined with concrete and concrete alone.

The cast iron lining is 50 feet in length, and was placed as an aid in construction. The steel lining has a total length of some 400 feet, part to one side of the cast iron and part to the other side. It was not placed for the purpose of assisting construction; but to provide for permanent water-tightness more efficiently than could well be done with concrete alone.

The excavation of the shafts and the major part of the tunnel proceeded without unusual happenings. The general mode of prosecuting the work was to drive a heading involving the upper portion and to excavate, at some distance to the rear, the bench thus left. In order to hold the roof securely, it was deemed advisable to follow the heading excavation rather closely with the concreting of the arch. This was done throughout pretty much the whole length of the tunnel.

Naturally, the difficult section beneath the Bronx depression was reached sooner by the Bronx heading than by the heading from the Astoria end. The strata were water-bearing; but the tunnel continually advanced despite inflows and ordinary leakage. However, after a time, it seemed advisable to adopt some such measure as the placing of cast iron tunnel rings. Fortunately, rings of this character could be obtained without much delay because of the fact that patterns used for the Pennsylvania Railroad's North River tunnels were available. These corresponded to a tunnel section different in size and form from the one now desired; but as the size was abundantly able to include the gas-tunnel section, they were quite suitable. A 50-foot length of tunnel was



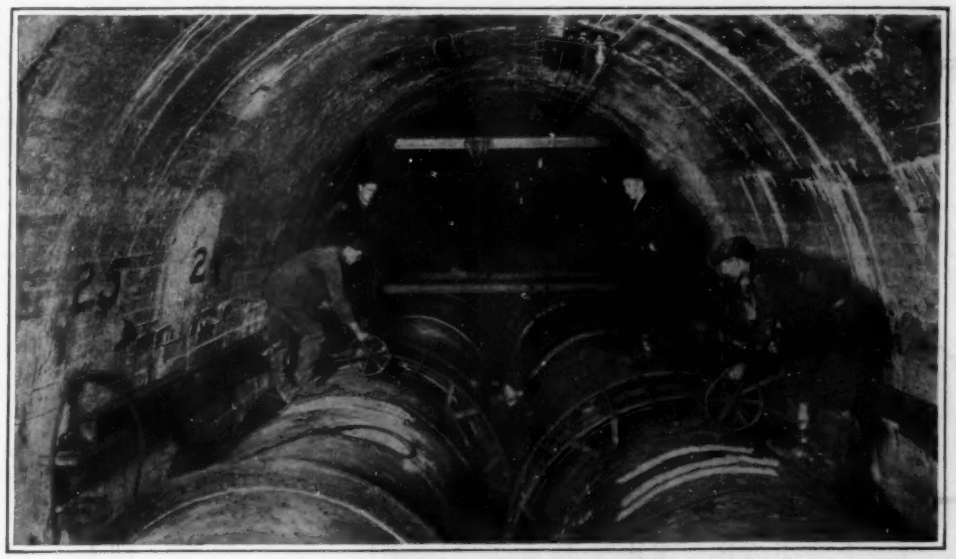
Pumping out the flooded Astoria shaft

Concrete blanket laid after the tunnel was unwatered

lined in this way and later on concreted to the required standard section.

Metal rings used for tunnel work in and around New York consist generally of circular segments corresponding each to 30 or 40 deg. and a final key segment inserted at the top. These segments have end side flanges which facilitate bolting end to end in radial planes and side to side in vertical planes. The vertical joints separate individual rings. A ring will cover 2 or 3 feet of tunnel length. The various segments will usually, or at least frequently, be provided with a grouting hole. These holes permit the metal lining to be filled in behind—that is, between lining and rock—with cement grout. The lining may then be covered within the tunnel by a layer of concrete.

While the Bronx heading was advancing, so also was that from Astoria. Finally, they met at a point nearer



Using calking machines on the two big gas mains

the Bronx end of the tunnel. There was then unexcavated a 474-foot length of bench. About half of this bench was excavated without causing any serious disturbance of conditions, the removal proceeding from the Astoria end. The bench was also attacked from the Bronx end, but with perhaps greater care, only part of the rock encountered being in a sound condition.

The system pursued on both sides was to explore ahead of the point of excavation. Bore holes would be drilled in advance of the point of actual excavation with the view of testing conditions. The holes were not limited to the exact prism of the tunnel but were managed so as to include adjacent regions. The concrete lining above the bench required that blasting be done with a good deal of care. After proceeding for a time, four of the bore holes originating on the Astoria side revealed a dangerous amount of water just ahead. It was necessary to get ready for it before pressing on with the excavation.

By this time, the length of bench had been reduced to 122 feet. The problem of its removal promised to be a battle in which the fighting was not going to be all on one side. The engineers proceeded in a manner that showed they had a good deal of respect for the Atlantic Ocean, an arm of which was immediately overhead. As the event showed, their respect for the imminent conditions was not misplaced. Any breaks into the tunnel would be backed by an unlimited supply of water. On the other hand, the pressures would be limited to about 95 pounds per square inch, whatever the amount of water that might be let loose.

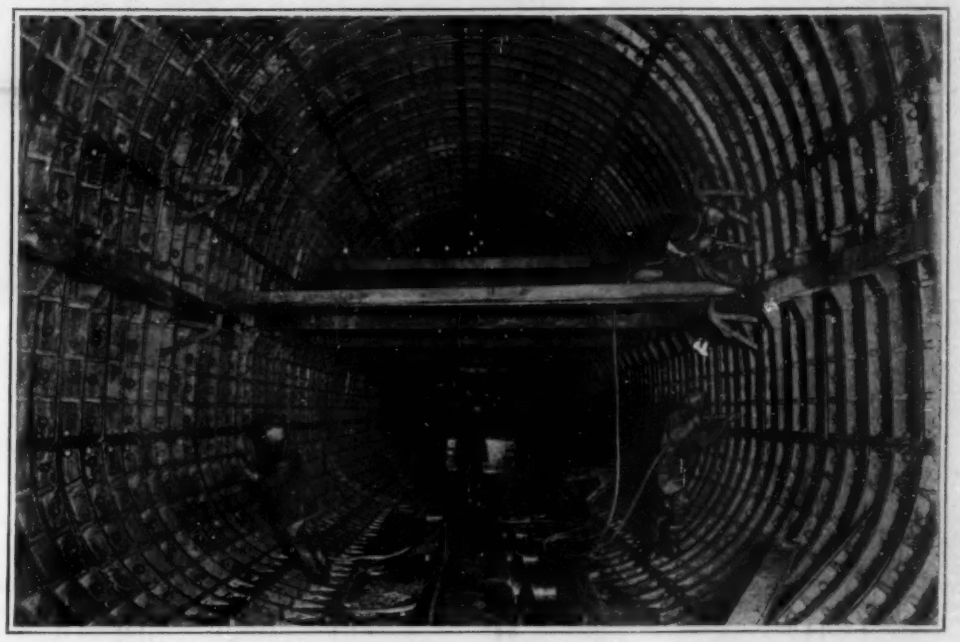
Near either end of the bench, at points where the excavation had been completed for the full section, great masses of concrete were placed in position to form bulkheads. These were provided with doors and drains to permit the passage of men, material and drainage water. The object in view was to limit any flood by closing all openings through the bulkheads. A third bulkhead was put in place in an intermediate position and in fact upon the bench itself. Conceivably, this might be used to limit still further the extent of tunnel that might become involved in a flood. The four bore holes had been piped for grouting and the pipes imbedded in an inclined buttress of concrete.

This inclined buttress was torn up and a bigger one put in place. At the Bronx end of the scene of activity and concern, another buttress was put in place. Taking the three bulkheads and the two buttresses into account, the whole western side of the bench was now under the protection of concrete. However, in preparing to force cement grout behind the buttress on the Astoria, or southern end, the buttress itself failed. It was a mass of concrete 34 feet long, 6 feet high and 12 feet thick, and yet the water pressure which began to the north. More than three fourths of the tunnel and practically the whole of one of the shafts were now in possession of the water.

It was fortunate, however, that the entire work had not been involved. This would have produced a situation of apparently extreme difficulty. The procedure in such case would probably have been directed to a cementing operation from the surface of the East River overhead. That is to say, bore holes would have been driven through the strata surrounding and including the section of tunnel where the break originated. Then cement grout would have been forced down with the view of causing it to penetrate and fill the fissures and cracks and then to solidify and so consolidate the whole into a mass of impervious rock. This procedure, if successful, would have enabled the engineers to unwater the tunnel and continue the excavation. It might indeed have become necessary in carrying out this program to fill up portions of the tunnel already excavated. After unwatering, these filled-in portions would have been excavated in much the same way as originally. The great difficulty in the way would have been the precise driving and maintenance of the bore holes and the steel tubing used for casing purposes. An uncompleted hole may be lost simply by the bending of the casing at or just below the river bottom.

Now, while grouting from overhead was not necessary, because of the preservation of the Bronx end, still the procedure of consolidating the disintegrated rock and of filling up a section of the tunnel was actually carried out. Bore holes were driven from the Bronx bulkhead which were directed with the view of intercepting the fissure through which the flood entered the tunnel. The first hole driven was successful. Further, the flooded chamber between Astoria and the Bronx bulkheads was penetrated from the Bronx bulkhead for the purpose of filling it up with cement. This also was successfully carried out. Over 12,000 bags of cement were consumed in these operations. The tunnel was now unwatered.

The fissure or fissures which caused the flooding of the tunnel were grouted further by means of long test holes, the object being to consolidate the rock well outside the tunnel lines.



Workmen calking the steel lining that was used in the difficult section to make the tunnel watertight

gallons per minute. This was not an unheard-of inflow. However, all things are relative. The stream brought in water at a rate which was nearly double the effective capacity of the pumping plant at the Astoria end.

The doors of bulkheads were closed and also some of the drain pipes. Apparently, the workmen were forced out so quickly on the Astoria end that they did not have time to close the particular drain pipe that ran through the Astoria full-section bulkhead. Consequently, here was a passageway for high pressure water into a main length of the tunnel. But this was not all. A small board, 1 inch thick, became wedged between the bulkhead door and the frame. Thus was provided another opportunity for the high pressure water.

The workmen made good their escape; but the water made such headway that in 5 hours the Astoria pumps were flooded and put out of commission. In the course of 24 hours, the Astoria shaft was full of water—all the way up to tide level. On the Bronx side, the tunnel and shaft were clear, the smaller bulkhead on top of the bench sufficing to shut off the flood from penetrating to the north.

It will be recollected perhaps that a 122-foot length of bench was still unexcavated when the flooding occurred. In order to provide against all eventualities in removing this water-bearing rock, the engineers took a number of special precautionary measures. The rock was explored with still greater care in advance of excavation; a heavy blanket of concrete in the form of an inverted arch was put in place; and the further consolidation of the rock carried out through the exploratory holes. The arch was made 2 feet thick. The space between it and the arch overhead was only 8½ feet high; so that special measures had to be taken in connection with driving test holes to the full depths necessary.

The tunnel has been fully excavated, fully lined, and is now being equipped with its pipe lines. These are the largest cast-iron pipes ever made. The risers which carry the tunnel lines up the shafts are of the same size. The weight on the joints in the risers—especially in the lower parts of the shafts—is so enormous that it has been deemed advisable to provide accurately machined contact surfaces in order to make the bearings as perfect as possible.

The Heavens in November, 1915

The Lesser Members of the Solar Family

By Prof. Henry Norris Russell, Ph.D.

IF one has lost track for a few years of the rate of addition of new members to our list of the sun's family of planets, its present status may well be surprising. At the present time, no less than 799 planets are known, each pursuing its own orbit. Only eight of these are large—the familiar planets. The other 791 belong to the group of the minor planets, or asteroids.

The first four of these little planets—Ceres, Pallas, Juno and Vesta—were discovered at the very beginning of the nineteenth century, between 1801 and 1807. No further additions to the list were made till 1845. Between that date and 1891 nearly 320 additional planetoids were discovered—an average of seven per year. The only way to find them was then to make a chart of the stars in some region of the heavens, and to go over it with the telescope again and again until some uncharted body was found, which—if not a variable star—would be a planet which had just moved into the region. This is so laborious that it speaks volumes for the industry and skill of the observers who discovered so many asteroids by usual observations.

The photographic method of discovery—introduced in 1891 by Wolf at Heidelberg—is far easier, and almost automatic in its action. On a photograph taken with an exposure of two or three hours, the stars appear as dots, but a planet, on account of its motion, as a little streak, or trail, so that it can be picked out at once. A later refinement of this method, introduced by Metcalf, the most successful American discoverer of these little planets, consists in moving the instrument so that it follows, not the stars, but the probable rate of motion of an asteroid. The stars then appear as trails, and the planet as a dot— thus concentrating its light, so that the discovery of very faint objects is possible.

In the 24 years since the photographic discoveries began, six or seven hundred new asteroids have been found—but a good many of them have got away again, before a sufficient number of observations of them had been obtained to make it possible to calculate trustworthy orbits and predict their places in future years, so that the total number included in the list for which reliable orbits have been found is now 791, as aforesaid. Even this makes an average of nearly twenty new planets every year, and the number added to the list last year was 37.

There are no signs of exhaustion of the group. The average magnitude of the asteroids discovered just after the introduction of the photographic method was 12.3, and now it is 13.0—that is, the ones now being found are about twice as faint. But, since considerably fainter objects can easily enough be photographed, it is probable that many hundreds of additional discoveries will be made before the limit accessible with our present instruments is even approximately reached, and that the list of those for which orbits can be computed will ultimately run to at least 1,500.

Almost all the brighter ones have probably been picked up, and from the run of recent discoveries, it seems unlikely that there are many more to be found which surpass the eleventh magnitude, but the number of the fainter ones must be legion.

Concerning the real size of these little planets we know something, and can upon a rational basis estimate a good deal more.

The four "oldest" asteroids show very small, but measurable, diameters when viewed with the greatest telescopes. According to Professor Barnard's measures Ceres is 480 miles in diameter, Pallas 304, Juno 120, and Vesta 240.

Ceres, the largest, is therefore a little less than one quarter of the diameter of the Moon, and its mass, which can only be estimated from its bulk, by assuming it to consist of material similar to the superficial layers of the Earth or Moon, is probably about 1-100 that of the Moon, or 1-8000 of the Earth's mass.

Knowing the diameters of these four little bodies, and their observed brightness, we may calculate their reflecting power for sunlight. It is found that Ceres, Pallas and Juno are fairly similar in reflecting power, diffusing away into space about 15 per cent of the incident sunlight—about the same fraction as does the planet Mars. Vesta, however, when at the same distance, appears brighter than Ceres, though only half as big, and must have a much higher reflecting power—probably nearly 50 per cent, resembling Venus in this respect.

It is rather remarkable that there should be such great differences in the whiteness of the surface of these small bodies, but there can be no doubt of the correctness of the observations upon which these conclusions are based.

For the host of smaller asteroids, we can only estimate the diameters on the basis of the amount of light which they reflect—and the case of Vesta warns us that our estimates may sometimes err considerably.

Nevertheless, if we assume such a reflecting power (about 18 per cent) that, on the average, the estimated and actual diameters of these four asteroids would agree, we shall probably not go very far wrong in estimating the size of the fainter ones on the same basis. We thus find that, in addition to the four already named, there are some twenty other asteroids which are likely to be more than 100 miles in diameter—though probably none of these exceed 150 miles—that there are about 150 more with the diameters between 50 and 100 miles, and an additional 450 between 20 and 50 miles, leaving somewhat over 150 which are probably less than 20 miles in diameter. An asteroid less than 10 miles in diameter is too faint to be observable unless it comes unusually near the earth: but one remarkably little one which was picked up by accident under such circumstances has an estimated diameter of only two miles!

This calculation would lead us to estimate the *combined* bulk of all the 787 fainter asteroids (and probably also their combined mass) as hardly greater than that of Ceres, and certainly less than the combined bulk (or mass) of Ceres and Pallas.

This reckoning, however, takes no account of the multitude of planetoids still undiscovered. We can do little more than guess at their number or size: but a study of the nearer asteroids (among which those of small size are most likely to be discovered) show that, while the number of the smaller ones rapidly increases, this increase is not fast enough to overcome the influence of their smaller bulk, so that the total bulk (and therefore probably the mass) of the fainter ones is but a fraction of that of the less numerous, but larger, bright ones. On this basis it may be estimated that the whole mass of all the asteroids, including the probable thousands of tiny ones too faint for us to see with powerful instruments, is but two or three thousandths of the earth's mass, or enough at most to make a single body from 1,000 to 1,200 miles in diameter—far smaller than the Moon, the four principal satellites of Jupiter, the largest satellite of Saturn, or that of Neptune. Such a body, if of the same reflecting power as Ceres and at the same distance, would be only of the fifth magnitude, and inconspicuous to the naked eye.

At 11 o'clock: Nov. 7.
At 10½ o'clock: Nov. 14.
At 10 o'clock: Nov. 22.

At 9 o'clock: Dec. 7.
At 8½ o'clock: Dec. 15.
At 8 o'clock: Dec. 23.

At 9½ o'clock: November 30.

NIGHT SKY: NOVEMBER AND DECEMBER

The Heavens

The brilliant group of winter constellations has now come well up into the evening sky. Sirius is still low in the southeast, but Orion shows grandly above him, and Taurus is higher still. Procyon is to the left of Sirius, and about equally high at our hour of observation (which is marked below the chart). Above him is Gemini, and, still higher, Auriga, beyond which we reach Perseus, almost overhead. Andromeda and Pegasus, extending almost westward from the zenith, are the most prominent constellations in this region. The southern sky is very dull, the only conspicuous object there being the planet Jupiter which is on the border of Aquarius and Pisces.

The isolated stars Fomalhaut and Beta Ceti, in the southwest, seem brighter than they really are, because they stand so much alone.

Cygnus and Lyra are still in sight in the northwest, Cassiopeia is high above the pole, Cepheus below and to the left, Draco and Ursa Minor below the pole, and Ursa Major is coming up in the northeast.

The Planets

Mercury is a morning star this month, and is well visible at its beginning, being at his greatest elongation on the 7th. Though only 19 deg. from the Sun he is nearly 9 deg. north of him, and so rises an hour and forty minutes earlier, or at about 5 A.M.

He is on Virgo, not far from the first-magnitude star Spica, which he greatly excels in brilliancy. Toward the end of the month he gets nearer the Sun and farther south, and becomes hard to see.

Venus is an evening star, but is unfavorably placed, setting less than an hour after the Sun.

Mars is in Leo and is in quadrature with the Sun on the 9th, at which time he rises about 11 P.M. He is rapidly growing brighter, but is not nearly as conspicuous as he will be early in 1916.

Jupiter is on the meridian at 8:41 P.M. on the 1st and 5:36 on the 30th, and is the brightest object in the evening sky. Saturn is in Gemini, and rises about 8:15 P.M. in the middle of the month.

Uranus is in Capricornus, and is in quadrature with the Sun on the 5th. He is observable in the early evening. Neptune, being in just the opposite part of the sky, is visible only in the morning hours.

The Moon is new at 3 A.M. on the 7th; in her first quarter at 6 P.M. on the 13th; full at 1 P.M. on the 21st, and in her last quarter at 5 P.M. on the 29th. She is nearest the Earth on the 2d, and farthest away on the 23d. As she sweeps around the heavens she comes into conjunction with Mercury on the 5th, Venus on the 8th, Uranus on the 13th, Jupiter on the 15th, Saturn on the 25th, Neptune on the 26th, and Mars on the 28th.

Princeton University Observatory.

The Colored Man as an Inventor

THE exposition at Chicago, August 22nd to September 16th, in celebration of the fiftieth anniversary of the emancipation of the colored race includes an exhibit of more than a thousand patents which have been granted to those of that race. Manifestly the list will be incomplete, as it is impossible to determine from the Patent Office records whether an applicant and patentee is white or colored, but much effort has been made by Henry E. Baker, who has been detailed by the Commissioner of Patents in charge of the patent exhibit to make it as complete as possible. Mr. Baker, himself a colored man, is an assistant examiner in the Patent Office, having entered such office in January, 1876, as a copyist. He was appointed to the examining corps in March, 1883, and has been promoted from time to time to his present position as second assistant examiner. Another colored man, Edward O. Clarke, was appointed to the examining corps in August, 1893, but resigned to accept a professorship in a college.

Hand trap with target in the carrier

The operator of the hand trap stands a few feet behind the shooters

Method of setting the hand trap

New Hand Trap and Its Possibilities

THE growing popularity of trap shooting with American sportsmen is responsible for the recent introduction of a hand trap. With the use of the new apparatus it is now possible to enjoy this form of sport anywhere: no longer must it be confined to club grounds, as in the past, because of the expense of installing a permanent trap.

Weighing about 6¼ pounds, the hand trap is readily carried in a special case or placed in the traveling bag of the sportsman, taking up but little room and adding only a few pounds to the weight of the baggage. Although its operation is simple, it can throw targets in a wide variety of angles, keeping the most trained trap shooters on the alert. Good trap shooters admit that their scores are better at the club after they have had some practice with a hand trap.

The frame of the hand trap is of malleable iron, while a powerful spring supplies the propelling force to the target. The latter is held by mechanical fingers in a carrier and is released by a trigger. Adjustments may be made to hurl the target at any angle and in any direction. Targets can be thrown from 60 to 80 yards, depending on the skill of the operator.

The hand trap adapts itself to a variety of uses that are denied the usual traps which must be permanently installed. It is ideal for private trap shooting parties, picnics, hunting parties—particularly when game is not plentiful—and for practice on the decks of motor boats. As to its last employment, it is said that shooting from a moving motor boat is the best kind of sport, and to this end the hand trap readily adapts itself.

Tennis as Compared to Golf

By Dwight Douglass

California Professional Tennis Instructor

UNTIL one really considers the matter, tennis and golf seem to have much in common. Each is played with an elastic ball and a hitting instrument, and each is enjoyed by both ladies and gentlemen. There is a drive in tennis and a drive in golf; a follow-through in tennis and a follow-through in golf. In each the eye must be kept on the ball. Country clubs feature both tennis and golf. Magazines group the two games. The phrase "tennis and golf" is met everywhere.

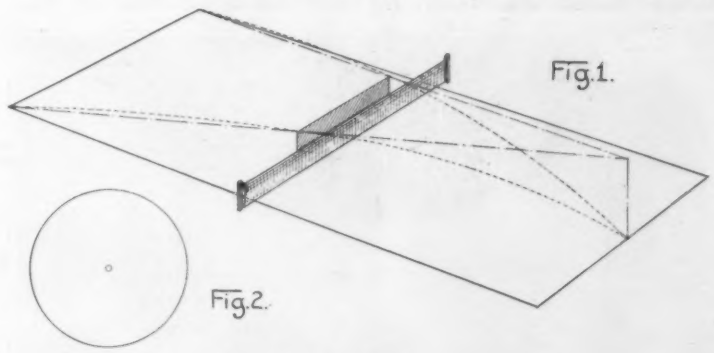
It is, therefore, not to be wondered at that amateur players and authors of books of instruction on tennis should drift into the common delusion that the tennis and golf drives are made on the same principle, and that the follow-through in tennis should in all respects be patterned after the follow-through in golf.

Now, it is well established that in golf the head of the club should meet the ball squarely, should follow directly after the departing ball as long as is practicable, and that the swing should finish around the body only after the ball is well on its way. It is plain that otherwise the ball will be sliced or else deflected laterally in its flight, and I doubt if there is any question as to the importance of this straight shooting at the distant mark.

So it seems plausible when one meets the statement that the follow-through should be made in tennis, as in golf, as far as possible in the direct line of the departing ball. But the writer has had so many pupils whose main difficulty lay in their too literal following of this advice, that it seems time to call attention to the radical difference between the drives in tennis and in golf, in order to remove the misconception under which the advice is given and followed.

Conditions could hardly be more different. The distance from tee to hole in golf is very long—frequently over 400 or 500 yards. But in tennis the back lines are only 26 yards apart. In golf the fair way varies, but is frequently about 50 yards wide, approximately one tenth the length of the driving distance. If this proportion were maintained in the dimensions of the tennis court, the court would be 270 feet in length, and its width 27 feet; or else the court would be 78 feet long, its present length, and less than 8 feet wide. Then lateral control would plainly be of primary, instead of secondary importance, as will soon appear. And possibly the worst feature of the attempt to secure lateral control is that it is so liable to be overdone, unless speed is sacrificed, and thereby to decrease the really important factor, vertical control.

Few realize how important vertical control is in tennis. The singles court is 27 feet wide. In doubles it is 36 feet wide. The length is 78 feet. But the net is 3 feet high. The net makes all the trouble. Also, it makes tennis a game of restraint and skill, rather than a slamming match. It corresponds in its function to the hazards in golf, that penalize wildness. While the rough grass and the other hazards accent the importance of driving the golf ball straight ahead, in tennis, on the other hand, the net makes the more difficult act the one of getting the ball first up and over



Tennis vs. Golf

Fig. 1. Shaded area above net shows approximate space within which ball may be driven safely. Vertical control is about six times as important as lateral control. Fig. 2. Proportional resistances. Inner circle represents resistance of golf ball to sweep of driver; outer circle, resistance of swift tennis ball to similar sweep of racket.

the net, and then down inside the limits of the opposite court, with enough speed to bother one's opponent. Lateral control is, of course, good to have, but vertical control is absolutely indispensable.

There must be speed in the tennis drive. An easy rainbow-arching drive is practically a gift to one's opponent. If the ball goes fast, it must go just over the net or within about 2 feet of it, depending on the amount of top-spin. Otherwise it will go out of court, and the point be irretrievably lost.

Now, with a net 27 feet wide, a simple study of angles will show that about half that width is available to the driver from the base-line, and that anywhere within that angle the ball may be sent and will land within the limits of the side lines of the opposite court. So it is plain that the tennis player driving from the base-line has a vertical target of only a foot or two, but a horizontal target of over 13 feet. Poor shooting if one cannot hit a 13-foot target only 39 feet away!

The more one considers the subject, the more strikingly dissimilar the games seem.

Golf is solitaire, played with or without a companion. One may compare scores with one's companion, and come out ahead or behind as the case may be, but the companion is never an opponent. He never opposes. He must do nothing at any time to render one's play difficult, except in the case of an occasional accidental stymie.

But the whole game of tennis is based upon the active opposition of an opponent. It cannot be played without it.

There is no time-limit in golf. In tennis the preparation for and execution of the drive is all concentrated within about four fifths of a second. Imagine teeing a golf ball and driving it in that length of time!

There is no back-hand stroke in golf.

There is time to deliberate in golf. There is literally not time to even think in tennis. The whole action is so quick that there is not time to think consciously about either stroke or position. One must depend absolutely upon habit and reflex action, or he will slow his game down hopelessly. Many people of clear but rather deliberate brain action are baffled by this requirement in tennis, and find golf more congenial.

But of all the differences, probably the one most generally overlooked is the difference due to the fact that the golf ball is still when hit, while the tennis ball is moving. This affects not only the difficulty of timing and judging it, but its main difference is in the force of the shock the hand encounters in making a flat or nearly flat hit with the racket. So great is this shock that the expert players to-day have instinctively learned to avoid it, almost if not quite entirely, by drawing the racket on the ball, and throwing the ball smoothly, by the centrifugal curve-throw, rather than hitting the ball at all squarely. They not only save the hand and arm from shock, but, by skillful weight shifting and a powerful pull on the arm, they send the ball by a throw similar in principle to the throw of a lacrosse ball, faster than they could have knocked it with a flat hit. This principle was more fully treated by the writer in SCIENTIFIC AMERICAN, issue of September 18th, 1915.

The tennis ball weighs only about half an ounce more than a golf ball, but its velocity gives it a formidable force. We learned in the physics class in college that the force equals half the mass multiplied by the square of the velocity, so it is plain that when the racket is brought up squarely against a 2-ounce ball moving about 100 feet a second—over a mile a minute—it is not possible for the human arm to swing the racket through with the swift, unchecked, instantaneous knock and sweep with which the heavy-headed golf club knocks the stationary golf ball ahead. It is plain that the strokes must be made upon entirely different principles, and that is the case among the better players to-day.

The force of a swiftly flying tennis ball coming squarely up against a racket in an instantaneous shock is greater than that of a 10-pound sledge hammer swung at the rate of 10 feet a second. Expert tennis players have learned to avoid this instantaneous shock by the sliding sweep I have described. But this is not possible in golf, in which the force must be concentrated and applied instantaneously.

It is plain, therefore, that if one were to attempt to drive a golf ball large enough to offer the same resistance that a tennis racket encounters, the ball would be so large that the shaft of the driver would be splintered by the collision.

Mortality Among Physicians in Serbia

Official statistics show that 82 Serbian physicians have died of typhus since the beginning of the war, while of the foreign physicians on duty in Serbia 35 have succumbed to typhus or typhoid fever.

Inventions New and Interesting

Simple Patent Law; Patent Office News; Notes on Trademarks

Partial view of a mine cave-in due to faulty props and roofing

Faulty Bracing Results in Mine Cave-Ins

WHEN the European war recently sent the price of zinc ore to above $100 a ton, the abandoned lead and zinc mines at Galena, Kansas, in the Joplin district, were the scene of great activity. The miners started to work the mines again for "small diggings" and new prospects. In the haste with which the work was begun, some of the mines were not carefully examined as to the condition of their props and roofing, resulting in cave-ins.

In the accompanying illustration appears part of a cave-in of two acres in extent that occurred at Galena, shortly after the beginning of activities. The surface sank from 10 feet in some places to 50 feet in others. The mine engine shack which may be seen in the foreground fell 20 feet without altering its relative position, while a motor car which stood just to the right of it prior to the cave-in was completely lost. This, it is said, was caused by the grinding motion of one part of the earth dropping before another mass of earth adjoining it. Fortunately, no men were in the mine at the time of the disaster. Four men who stood on the surface at the time of the disaster were carried down in the debris, only one of them being seriously hurt.

Gasoline-Operated Railway Weed Mower

IN order to eliminate the expensive and slow method of cutting weeds along the railroad tracks with scythes, a motor car mowing machine that cuts a swath 6 feet wide on both sides of the track has just been produced. The car is similar in general construction to the motor inspection cars now comparatively common on railroads. However, it is equipped with two cutter bars much like those of a farm mower, extending on each side of the car.

When engaged in cutting weeds, the car is driven at a speed of 3 miles an hour. The cutter bars are so arranged that, by the movement of levers, they may be raised or lowered to avoid obstacles along the track and to compensate for irregularities in the ground.

It is claimed that the machine will cut 25 miles of road bed in a day and at an average cost of $7 for the services of three men required to operate the car and for fuel and oil for the motor. The car, with its crew of three men in charge, will do the work of 100 men with scythes.

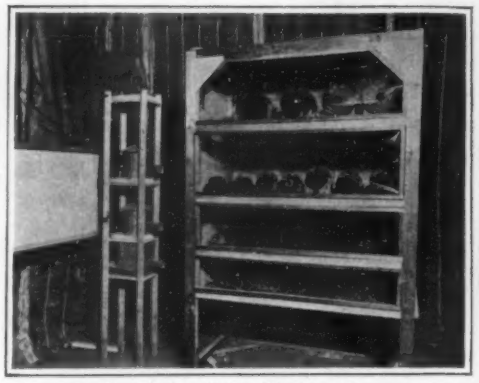
The gasoline motor is rated at 6 horsepower, and when the cutter bars are raised, it drives the car at a speed of 15 miles per hour. The car starts without pushing, as is necessary with most railway motor cars, and is so arranged that it will pull itself on or off the track.

Dressing Railroad Ties with Compressed Air Chisel

IN the preparation of a railroad tie, the cost of the labor involved in dressing the timber is an important consideration. The work is done by hand and a rather high grade of labor is required; a workman untrained in the use of the axe with which the work is done would have to spoil but few pieces to make himself an expensive proposition.

The dressing of ties is being revolutionized by the introduction of a pneumatic tool which, in the hands of an wholly inexperienced workman, can do more work in less time and quite as well as the trained tie-peeler. Under the old method, the skilled workman has an average capacity of sixty ties per day of ten hours. A few may do much better than that, and the average cost of peeling is about 5 cents. With the air-driven tool, however, 150 ties may be easily dressed in the same length of time.

When one takes into consideration the fact that there are approximately 6,000 ties in a mile of double-tracked road, it will be realized that the matter of peeling the sticks of timber represents an important item of expense. The pneumatic method is said to show a saving of 2 or 3 cents on each tie. One of the accompanying illustrations shows the new tie-peeling tool at work, while the other depicts a complete portable plant for such work.



Apparatus installed in Johns Hopkins University for determining quality and intensity of violin tones

Motor car fitted with adjustable scythes for cutting weeds along a railroad right-of-way

Portable gasoline-driven compressor which supplies air to the pneumatic tie-peeler

Method of using a pneumatic-driven chisel for the dressing of railroad ties

Apparatus for Determining Quality and Intensity of Violin Tones

By Dorsey Richardson

AN invention of great importance to musicians has been recently completed in the physical laboratory of the Johns Hopkins University, at Baltimore. It is an apparatus for testing the quality of violin tones and hence the excellence of violins themselves. The inventor is Clarence Wilson Hewlett, of North Carolina, instructor in physics at the university, who has been working over the problem of testing complex sound waves for a period of three years. He has at length evolved a very satisfactory and dependable mechanism which will record the most delicate overtones and partials of violin sounds.

The working of the new apparatus depends on the elementary principles of sound. If the same note is played in succession on several different instruments, a listener, with the most inexperienced ear, will decide that the sounds heard are quite different; while one with a very elementary musical training will be able to decide, in most cases, from the sounds alone the particular instrument that is being played when the tone is produced.

The position of a tone on a musical scale is determined by its pitch, or the number of vibrations per second; and two musical instruments are said to produce the same tone when the vibrating parts of the two are vibrating at the same rate. Different kinds of musical instruments produce different "qualities of tone," even when playing the same note. The quality of the note depends upon the manner in which the instrument vibrates, that is to say, upon the degree of complexity of the vibration. The air in contact with the musical instrument takes up, repeats and transmits to the human ear the vibrations of the musical instrument.

Vibrations of all degrees of complexity can be built up of simpler vibrations known as "simple harmonic vibrations"; and when physicists are able to find which of these simple harmonic vibrations to combine in order to produce a given vibration, they are able to say that they have analyzed this vibration into its simple harmonic components.

The apparatus evolved by Dr. Hewlett

(*Concluded on page 387.*)

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RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Electrical Devices

TROLLEY STOP.—E. E. CONRAD, Genoa, Wis. This improvement relates to overhead trolley systems, of the type used in factories, canneries, packing-houses, etc., with a particular reference to the switch positions in the tracks, and one of the main objects is to provide means at an open switch for preventing the trolley from falling from the end of the track.

STARTING BOX.—M. TAIGMAN, 241 Wooster St., New York, N. Y. The inventor provides means for discontinuing the electric-current supply to the box when the retracting spring becomes broken; provides means for preventing the fragment end of a retracting spring from energizing the structural parts of the box; and provides means for preventing movement of the switch lever of the starting box after the breakage of the retracting spring.

Of Interest to Farmers

CORN HARVESTER.—J. LIEBL, care of Farmers' Bank, Emery, S. D. This corn harvester is adapted to automatically pull ears from their stalks and to deliver the same to rollers, by which they are husked. A beater projects beneath and transversely across the snapping rollers and coacts therewith to prevent the same from becoming clogged. Means provide for moving the husks from the corn in a quick and expeditious manner.

COTTON GIN.—A. A. ZALONDEK, 127 F St., West, Capitol Hill, Okla. This apparatus obviates many difficulties incident to ginning machinery which usually includes a horizontal shaft on which the saws are mounted and spaced apart to operate through a breast of ribs in their rotation, the cotton to be ginned being fed onto this breast and acted upon by the saws in the well-known manner.

CULTIVATOR.—E. MELTON, Clovis, N. Mex. The object here is to provide a double row sled cultivator for listed ground, with novel features provided whereby the sleds are rendered self adjustable in the rows, may be raised and lowered to and from the ground, and may have means for effectively guiding them in operation.

Heating and Lighting

FLUE BLOWER.—G. H. VAN SCHAICK, Hudson Falls, and P. Burns and J. Reardon, Fort Edward, N. Y. Address the first, 9 Kathrin St., Hudson Falls, N. Y.

FLASH LIGHT.—H. M. KORETZKY, care of Bright Star Battery Co., 430 W. 14th St., New York, N. Y. This invention relates to flash lights of that type adapted to be carried in the pocket and always available for use. It provides a novel arrangement of lamp, push button contacts and cell within the narrow compass of an ordinary watch case, and at the same time provides a cell of considerable capacity compared with the available space for its storage.

HOT AIR FURNACE.—D. P. KURTZ, Elkhart, Ind. An object here is to provide a form of grate, wherein mechanism is provided for movement between the fuel on the grate and the grate, and operated from outside the furnace. Another object is to provide a feeding mechanism extending from the top of the outer casing into the fire box at the center of the grate, and mechanism for lifting coal from the bottom of the outer casing to the top of the fuel chute, and to provide mechanism in connection with the grate for deflecting the fuel to all parts of the grate.

Household Utilities

CLOTHES PIN.—F. LUERSEN, P. O. Box 63, Price, Utah. The invention relates particularly to a form of clothes pin so constructed that series of the pins may be strung on a clothes line and be movable thereon to different relative positions. The respective pins have a plurality of clamping means so that a pin may form a connection between garments on a line in suspending the same.

COMBINATION CONDIMENT HOLDER AND CUTLERY UTENSIL.—G. M. DENNIS, Van Houten, New Mex. This invention provides a fork or knife, spoon or any other suitable and desirable article with a handle formed of a pair of condiment holders slidably positioned relatively to the article and capable of being partially removed therefrom whereby to allow seasoning of food by the condiment contained in the holders.

CURTAIN SUPPORT.—J. V. KING, JR., and GEORGE E. RUFFLEY. Address the latter, Glenfield, Pa. The purpose here is to provide a support capable of quick attachment to or detachment from a window casement, and wherein means is provided for supporting a plurality of blind rollers, and a curtain pole in properly spaced relation, and wherein the blind rollers are balanced.

COOKING STOVE.—J. A. COPPRIDGE, Station 22, South Richmond, Va. This invention provides a device for cooking purposes which will make use of either solid or gaseous fuel with means for protecting the gas burners when solid fuel is used with the device. He also provides a device in which the change from

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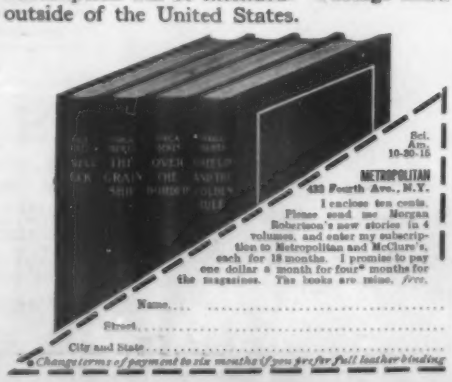
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Machines and Mechanical Devices

MARINE ENGINE THROTTLING APPARATUS.—O. J. McGOWAN, 518 55th St., Brooklyn, N. Y., N. Y. This invention provides a throttling mechanism adjustable to meet various conditions of service; anticipates under certain conditions the action of a vessel having a throttling mechanism of the character described; provides a throttling mechanism to operate in correspondence with both the roll and pitch of a vessel; provides means for independent tuning of the various controls of the throttle valve; provides for operating the throttle in the event of racing taking place; and provides means for absorbing the shocks incident to the operation of the above mentioned mechanisms.

VARIABLE SPEED GEARING.—J. DOVE-SMITH, 1882 Niagara Ave., Niagara Falls, N. Y. This invention comprises a driving shaft, a driven shaft and change speed mechanism between said shafts including a countershaft and gear wheels of different sizes, together with pairs of parallel wedges eccentric to the driving and driven shafts to cause certain of the gears to be made operative, certain of said wedges acting at times to cause direct positive connection between the driving and driven shafts.

DRILL PRESS.—P. F. CONNON, care of Orin W. Ward, 96 5th Ave., New York, N. Y. This invention relates to metal working tools and has particular reference to boring and drilling devices. The device comprises a bracket which may be held in any desired position upon a fixed support or may be clamped to the bar, rod, plate or other job to be bored.

VENDING MACHINE.—S. GUADAGNINO, 175 Harrison Ave., Brooklyn, N. Y., N. Y. This invention provides a construction which will properly vend an article, the same being associated with a coin controlling construction which will operate only with a certain sized coin but will not become clogged or stopped up by the insertion of coins, washers or similar devices.

CASE FOR MOTION PICTURE FILMS.—W. P. MCNEEL, 1123 W. French Place, San Antonio, Tex. An object of this invention is to provide an inclosed casing wherein the operation of transfer or rewinding of a film from one reel to another is performed, protecting the film from danger incident to dust, grit or the like, as well as from the danger of fire.

FLEXIBLE COUPLING.—W. J. FRANCKE, New Brunswick, N. J. The aim in this instance is to provide a flexible coupling, more especially designed for use on the shafts of powerful machinery, and arranged to insure proper transmission of the power from one shaft to the other even should such coupled shafts be parallel or out of center.

Of General Interest

BOTTLE CAP AND OPENER.—F. G. SMITH, 366 Park St., New Bedford, Mass. The invention improves and simplifies the construction of bottle-caps and openers so as to be reliable and efficient in use, comparatively inexpensive to manufacture and so designed that the cap can be easily and quickly taken off the bottle or other container to which it has been applied.

THERAPEUTIC APPARATUS.—H. B. PHILIPS, 2816 W. 1st St., Brighton Beach, New York, N. Y. This invention has particular reference to devices adapted especially for the automatic drainage of empyema. It provides means for maintaining a desired negative pressure in the pleural cavity whereby the discharge of the pus is facilitated in a natural way and without danger of collapse of the lung.

BAG.—C. P. KLEEBAUER, 2117 Regent Place, Brooklyn, N. Y., N. Y. Among the principal objects which the present invention has in view are: To provide a bag suitable for carrying small articles with means for temporarily sealing the same; and to arrange the sealing means above-mentioned to furnish a handle or carrying device.

FEED BAG FOR HORSES.—J. H. HUCKE, Jr., 52 Madison St., Brooklyn, N. Y., N. Y. The object of this invention is the provision of a feeding device having what may be termed a magazine construction which will deliver into proximity to the horse's mouth a moderate amount of feed while the bulk of the feed is maintained on the magazine.

METALLIC BUILDING.—W. W. TAYLOR, 158 Walnut St., Montclair, N. J. The present invention is a division of application for Letters Patent, filed by Mr. Taylor November 12, 1913, Serial No. 800,493, which was itself a division of an application filed by him March 14, 1913, Serial No. 754,216. It relates more particularly to the ridge of the roof and to the co-acting roof plates.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

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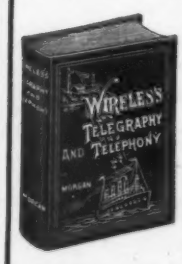

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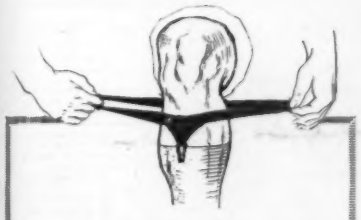

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Apparatus for Determining Quality and Intensity of Violin Tones

(*Concluded from page* 384)

enables this task to be accomplished. A given tone is produced by different musical instruments and the number and intensity of the various overtones present are determined from indications of the apparatus. In this way, it is possible to define physically the difference between the sound waves from a cornet and those from a violin, and to state the physical characteristics of an "ideal violin tone."

Dr. Hewlett's machine consists of a series of brass air resonators tuned to the fundamentals and overtones of the various tones to be studied. The resonators are composed of two pieces of telescoping brass tubing; one piece being closed at one end with a solid disc of brass and the other piece having a circular opening in its center. This opening is the mouth of the resonator; the arrangement enabling the resonators to be tuned over a somewhat wide range. A set of thirty-nine resonators is used, with frequencies ranging from 138 to 2,552 vibrations per second. The resonators are mounted side by side on the four shelves of a wooden case, which is a framework whose front sashes are covered with very thin celluloid, transparent to both light and sound, while the other sashes are covered with light tissue paper.

The resonator system for measuring the intensity of sound is as follows: A thin mica disc whose diameter is about half that of the opening in the resonator is suspended by means of a fine quartz fiber close in the opening. A small glass rod attached to the lower side of the disc terminates in a small glass dumb-bell which dips into a cup of kerosene oil. The object of the dumb-bell and oil is to damp the motions of the disc. In the center of the mica disc there is fastened a small chip of platinized concave mirror. The disc is turned so that its plane forms an angle of approximately 45 deg. with the mouth of the resonator.

When the resonator responds to a tone of its frequency the disc experiences a couple whose magnitude depends upon the angle between the plane of the disc and that of the mouth. The disc will therefore turn till the couple due to the fiber is equal and opposite to that caused by the vibrating air.

The kinetic energy per cubic centimeter in the air is the quantity that is to be determined when analyzing a complex wave, and it may be calculated from a knowledge of the deflection of the disc and the constant of the suspended system.

A large, translucent paper scale with vertical rulings 1 cm. apart is mounted in front of the case of resonators. The faces of the resonators are adjusted parallel to this screen. Four Nernst glowers, one for each shelf of the resonators, are provided with hoods each containing a small aperture. The glowers are mounted at the sides of the case, the apertures facing small celluloid windows; the rays of light entering these windows accordingly being perpendicular to the axis of the resonator.

The disc of the resonator is turned so that the chip of the mirror on its face is hidden from the glower, and an auxiliary mirror mounted on a lead wire serves to illuminate its surface. By this means, the image of the glower on the scale can be placed where desired without interfering with the disc or glower.

The room in which the experiments with Dr. Hewlett's machine were carried out was approximately 4 meters each way. Reflections from the walls, floor and ceiling distort the sound waves to such an extent that absolute measurements of the intensity of a source would be almost impossible if some means were not devised to eliminate these disturbances. With this end in view, the walls and ceiling were hung with a preparation of flax called Linofelt. This material is a fluffy, fibrous substance sewed between two strips of heavy paper. The Linofelt was first suspended by wires so as to completely hide the ceiling and walls, and the strips then sewed together. The surface of the paper exposed to the room was then stripped off, leaving the soft, hairy

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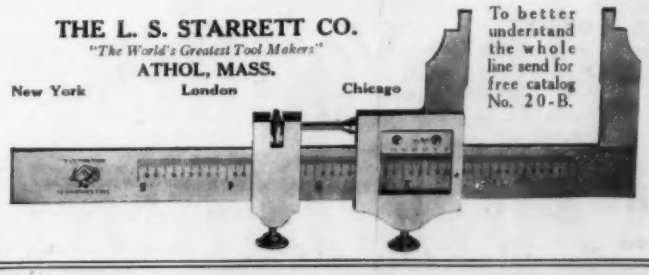

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surface exposed. The floor was also covered with Linofelt and then with a layer of burlap. The reflections were greatly decreased, although not entirely destroyed.

Thus far, the use of the machine has been confined almost exclusively to the analysis of the quality of the tone from the open strings of violins, although when the apparatus was designed it was intended to include some other instruments. When the apparatus has been further developed, it is intended to trace the development of singing voices by analyzing a number of tones sung by the voice again and again during its process of training.

A number of important facts have been found out in regard to the violin, among which is that when the open G string of the violin is played, hardly any of the energy of the vibration lies in the fundamental tone, most of it being due to the first partial. The best violins showed very few overtones; most of the energy lying in the first one or two and disappearing very rapidly thereafter. The poorest violins have many overtones with a very irregular distribution of the energy among these.

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I Più Recenti Progressi Della Technica Nelle Ferrovie e Tramvie. Ing. Pietro Oppizzi. Milano: Ulrico Hoepli, 1915. 16mo.; di p. 291; con 124 incisioni e tabelle. L. 5.50.

This little work is supplementary to the larger manual, "Ferrovie e Tramvie," and sketches the later developments of railway practice. It covers materials, construction, tables and statistics, and systems of transportation. The mathematics of the subject are briefly presented; bridges, tunnels and tracks are described in the text and their principles made clear by illustration; types of locomotive are dissected and explained; and statistics of Italian railways are given. Signal systems and electric traction are included in the brief exposition, and even the aerial railway is touched upon.

Irrigation and Settlement in America. By A. D. Lewis, M.A., A.M. Inst. C.E. Pretoria: The Government Printing and Stationery Office, 1915. 4to.; 258 pp.; illustrated. Price, 10s. 6d., post free.

Recognizing America's advanced position in irrigation, the author has here given us a faithful study of eighteen important schemes carried out in this country. In many places our engineers have most successfully combated aridity, thus opening up great stretches of country to white occupancy and useful industry, and from these happy results even more valuable lessons are to be learned, the author points out, than from our efficient high masonry or earthern dams, our design in valves, or our ways of draining seeped lands. His accounts are written from personal observation, and are not confined to the engineering aspect; they measure the success of a plan by the results it has accomplished in settlement, since failures in irrigation schemes have been due less often to poor engineering than to misunderstanding of agricultural conditions and other elements of human settlement. Many good photographs and maps enrich the volume.

Modern Plumbing Illustrated. A Comprehensive and Thoroughly Practical Work on the Modern and Most Approved Methods of Plumbing Construction. By R. M. Starbuck. New York: The Norman W. Henley Publishing Company, 1915. 8vo.; 407 pp.; 59 detailed plates. Price, $4 net.

Those who are familiar with this standard work in its earlier forms know its thoroughness and its clear interpretation of plumbing practice. In its new form it makes even a wider appeal than before. The plain drawings and the well-arranged text deal with all types of kitchen and bathroom installation, with refrigerators, soil pipes, and sewage disposal systems, from country house requirements to those of the largest office buildings and hotels. Since all recent advance in plumbing construction is rather in the development and perfection of details than in essential principles, it is in these details that the volume discloses its worth. The student of plumbing will find it a valuable text-book; to plumbers and architects it will be of the greatest usefulness; and property owners and home builders may learn from it how to avoid mistakes and secure the very best results from their investment.

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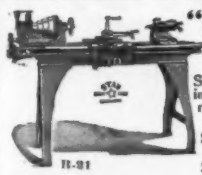

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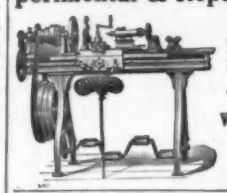

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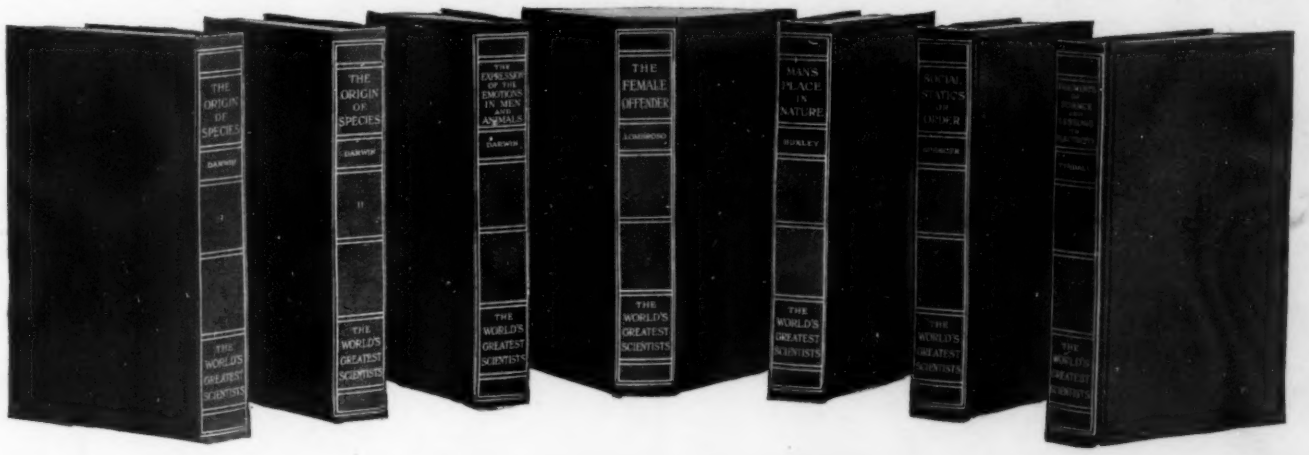

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8. Have you learned how to get well and keep well?	
9. Can you be optimistic, under all circumstances?	
10. Do you realize which of your habits, thoughts or emotions make you inefficient?	
11. Have you made an inventory of your mental and moral traits?	
12. Are you correcting your known weaknesses; mental, financial, social or spiritual?	
13. Have you discovered which foods, baths and exercises increase your energy and heighten your mentality?	
14. Do you breathe deeply and hold an erect posture?	
15. Is your sleep long and dreamless and refreshing, with your sleeping-room perfectly ventilated?	
16. Do you drink three pints of pure water daily?	
17. Do you eat slowly, moderately, regularly?	
18. Is all your clothing made loose, to allow blood and nerves free play?	
19. Are you independent, fearless, positive?	
20. Are you tactful, cautious, courteous?	
21. Have you secured the best possible advisers and associates?	
22. Are all your co-workers eager to help make your plans a success?	
23. Do you wish your rivals well, and never speak ill of them?	
24. Do you work harder than anybody else in the business?	
25. Have you learned the science of planning your day ahead?	
26. Can you relax entirely in your leisure hours?	
27. Are you saving money systematically?	
28. Do you enjoy art, music, literature, and the presence of little children?	
29. Does your highest ambition include some real service to Humanity?	
30. Have you a great love in your life, to steady, cheer and empower you?	

Divide the total by 30

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